BROOKHAVEN
NATIONAL LABORATORY

Work Permit # DRL-2010-17
Work Order # _____
Job# _____ Activity# _____

1. Work requester fills out this section. ☐ **Standing Work Permit**

Requester: Don Lynch	Date: 09/01/2010	Ext.: 2253	Dept/Div/Group: PO/PHENIX
Other Contact person (if different from requester): Jim LaBounty			Ext.: 7774
Work Control Coordinator: Don Lynch		Start Date: 09/01/2010	Est. End Date: 12/1/2010
Brief Description of Work: Installation of VTX detector subsystem in CM rgion of PHENIX IR			
Building: 1008	Room: IR	Equipment: VTX E & W	Service Provider: PHENIX techs

. WCC, Requester/Designee, Service Provider, and ES&H (as necessary) fill out this section or attach analysis

ES&H ANALYSIS					
Radiation Concerns	☒ None	☐ Activation	☐ Airborne	☐ Contamination	☒ Radiation
Radiation Generating Devices:	☐ Radiography	☐ Moisture Density Gauges	☐ Soil Density Gauges	☐ X-ray Equipment	
☐ Special nuclear materials involved, notify Isotope Special Materials Group			☐ Fissionable materials involved, notify Laboratory Criticality Officer		
Safety Concerns	☐ None	☐ Ergonomics	☐ Transport of Haz/Rad Material		
☐ Adding/Removing Walls or Roofs	☐ Confined Space*	☐ Explosives	☐ Lead*	☐ Penetrating Fire Walls	
	☐ Corrosive	☐ Flammable	☐ Magnetic Field*	☐ Pressurized Systems	
☐ Asbestos*	☐ Cryogenic	☐ Fumes/Mist/Dust*	☐ Material Handling	☐ Rigging/Critical Lift	
☐ Beryllium*	☐ Electrical	☐ Heat/Cold Stress	☐ Noise*	☐ Toxic Materials*	
☐ Biohazard*	☒ Elevated Work*	☐ Hydraulic	☐ Non-ionizing Radiation*	☐ Vacuum	
☐ Chemicals*	☐ Excavation	☐ Lasers*	☐ Oxygen Deficiency*	☐ Other	
* Does this work require medical clearance or surveillance from the Occupational Medicine Clinic? ☐ Yes ☒ No					
Environmental Concerns		☒ None	☐ Work impacts Environmental Permit No.		
☐ Atmospheric Discharges (rad/non-rad)		☐ Land Use	☐ Soil Activation/contamination	☐ Waste-Mixed	
☐ Chemical or Rad Material Storage or Use		☐ Liquid Discharges	☐ Waste-Clean	☐ Waste-Radioactive	
☐ Cesspools (UIC)		☐ Oil/PCB Management	☐ Waste-Hazardous	☐ Waste-Regulated Medical	
☐ High water/power consumption		☐ Spill potential	☐ Waste-Industrial	☐ Underground Duct/Piping	
Waste disposition by:				☐ Other	
Pollution Prevention (P2)/Waste Minimization Opportunity:		☒ None ☐ Yes			
FACILITY CONCERNS	☒ None				
☐ Access/Egress Limitations	☐ Electrical Noise	☐ Potential to Cause a False Alarm		☐ Vibrations	
	☐ Impacts Facility Use Agreement		☐ Temperature Change	☐ Other	
☐ Configuration Control	☐ Maintenance Work on Ventilation Systems		☐ Utility Interruptions		
WORK CONTROLS					
Work Practices					
☐ None	☐ Exhaust Ventilation	☒ Lockout/Tagout	☐ Spill Containment	☐ Security (see Instruction Sheet)	
☒ Back-up Person/Watch	☐ HP Coverage	☐ Posting/Warning Signs	☐ Time Limitation	☐ Other	
☐ Barricades	☐ IH Survey	☐ Scaffolding-requires inspection	☐ Warning Alarm (i.e. "high level")		
Protective Equipment					
☐ None	☐ Ear Plugs	☐ Gloves	☐ Lab Coat	☒ Safety Glasses	
☐ Coveralls	☐ Ear Muffs	☐ Goggles	☐ Respirator	☐ Safety Harness	
☐ Disposable Clothing	☐ Face Shield	☐ Hard Hat	☐ Shoe Covers	☒ Safety Shoes	☐ Other
Permits Required (Permits must be valid when job is scheduled.)					
☒ None	☐ Cutting/Welding	☐ Impair Fire Protection Systems			
☐ Concrete/Masonry Penetration	☐ Digging/Core Drilling	☐ Rad Work Permit-RWP No			
☐ Confined Space Entry	☐ Electrical Working Hot	☐ Other			
Dosimetry/Monitoring					
☐ None	☐ Heat Stress Monitor	☐ Real Time Monitor	☐ TLD		
☐ Air Effluent	☐ Noise Survey/Dosimeter	☐ Self-reading Pencil Dosimeter	☐ Waste Characterization		
☐ Ground Water	☐ O_2/Combustible Gas	☐ Self-reading Digital Dosimeter	☐ Other Check O2 level prior to entry		
☐ Liquid Effluent	☐ Passive Vapor Monitor	☐ Sorbent Tube/Filter Pump			
Training Requirements (List below specific training requirements)					
CA –Collider User, PHENIX Awareness, Working at heights					
Based on analysis above, the Walkdown Team determines the risk, complexity, and coordination ratings below:			**If using the permit when all hazard ratings are low, only the following need to sign: (Although allowed, there is no need to use back of form)**		
ES&H Risk Level:	☒ Low	☐ Moderate ☐ High	WCC:	Date:	
Complexity Level:	☐ Low	☒ Moderate ☐ High	Service Provider:	Date:	
Work Coordination:	☒ Low	☐ Moderate ☐ High	Authorization to start	Date:	
			(Departmental Sup/WCC/Designee)		

3. Both work requester and service provider contribute to work plan (use attachments for detailed plans)

Work Plan (procedures, timing, equipment, and personnel availability need to be addressed): During the 2010 Shutdown, PHENIX will be installing the new VTX detector subsystem. The procedure for accomplishing this is contained in the attached installation procedure.
Special Working Conditions Required: None
Operational Limits Imposed: Modification work limited to lower octants easily reachable when standing on lower magnet superstructure.
Post Work Testing Required: No

Job Safety Analysis Required: ☐ Yes ☒ No	Walkdown Required: ☒ Yes ☐ No

Reviewed by: Primary Reviewer will determine the size of the review team and the other signatures required based on hazards and job complexity. Primary Reviewer signature means that the hazards and risks that could impact ES&H have been identified and will be controlled according to BNL requirements.

Title	Name (print)	Signature	Life #	Date
Primary Reviewer				
ES&H Professional				
Other				
Other				
Work Control Coordinator	Don Lynch		20146	
Service Provider				
	Review Done: ☐ in series	☐ team		

4. Job site personnel fill out this section.

Note: Signature indicates personnel performing work have read and understand the hazards and permit requirements (including any attachments).

Job Supervisor:		Contractor Supervisor:	
Workers:	Life#:	Workers :	Life#:

Workers are encouraged to provide feedback on ES&H concerns or on ideas for improved job work flow. Use feedback form or space below.

5. Departmental Job Supervisor, Work Control Coordinator/Designee

Conditions are appropriate to start work: (Permit has been reviewed, work controls are in place and site is ready for job.)

Name:	Signature:	Life#:	Date:

6. Departmental Job Supervisor, Work Requester/Designee determines if Post Job Review is required. ☐ Yes ☐ No

Post Job Review (Fill in names of reviewers)

Name:	Signature:	Life#:	Date:
Name:	Signature:	Life#:	Date:

7. Worker provides feedback.

Worker Feedback (use attached sheets as necessary)
a) WCM/WCC: Is any feedback required? ☐ Yes ☐ No

b) Workers: Are there better methods or safer ways to perform this job in the future? ☐ Yes ☐ No

8. Closeout: Work Control Coordinator (authorizing dept.) checks quality of completed permit and ensures the work site is left in an acceptable condition. (WCC can delegate clean up of work area to work supervisor)

Name:	Signature:	Life#:	Date:
Comments:			

VTX Detector Half Assembly

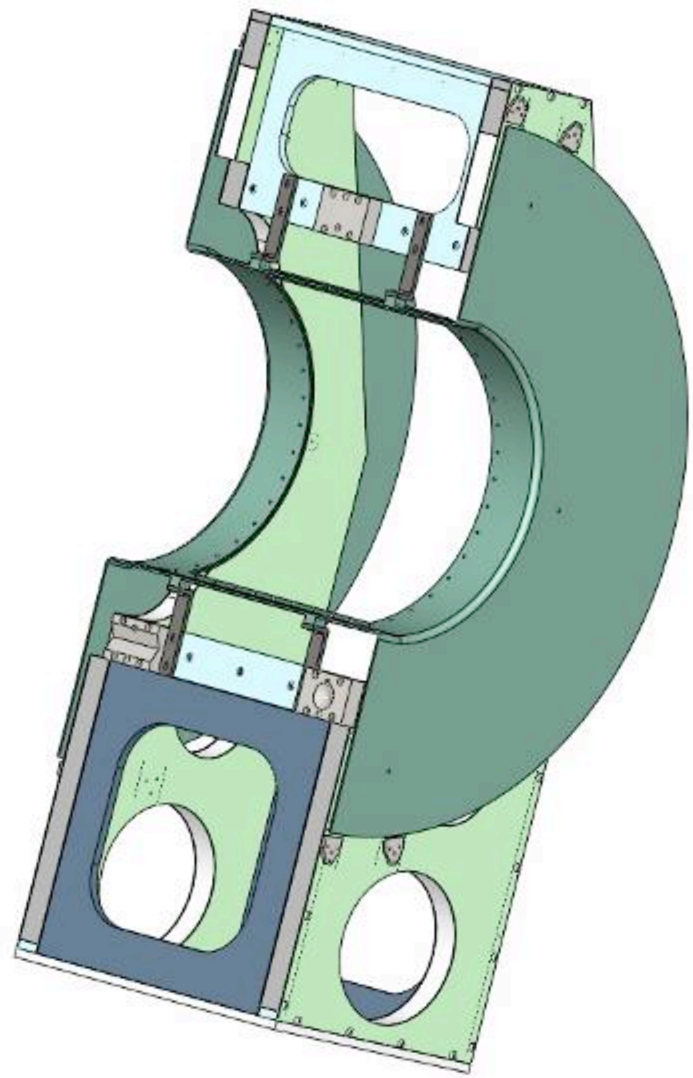
Walter Sondheim,
For the VTX Collaboration

Overview:

- Presentation depicts all of the major steps necessary to integrate the four VTX Barrel Detector Layers with the BNL support structure.
- Primary function is to cover assembly process flow and incorporate references to drawings and hardware as needed for this assembly.
- A copy of HYTEC and BNL drawings should be made available for reference.

Attach gas enclosure to BNL support structure

- Gas enclosure attaches to BNL assembly fixture at four points, 2 each at top and bottom of window frame via angle brackets 111-PHX-02-2211
- Spacer blocks need to be added to the BNL assembly fixture sides to fill gap between it and the gas enclosure spool piece ½ disks, make use of cross-rod attachment hole (used for shipping only)

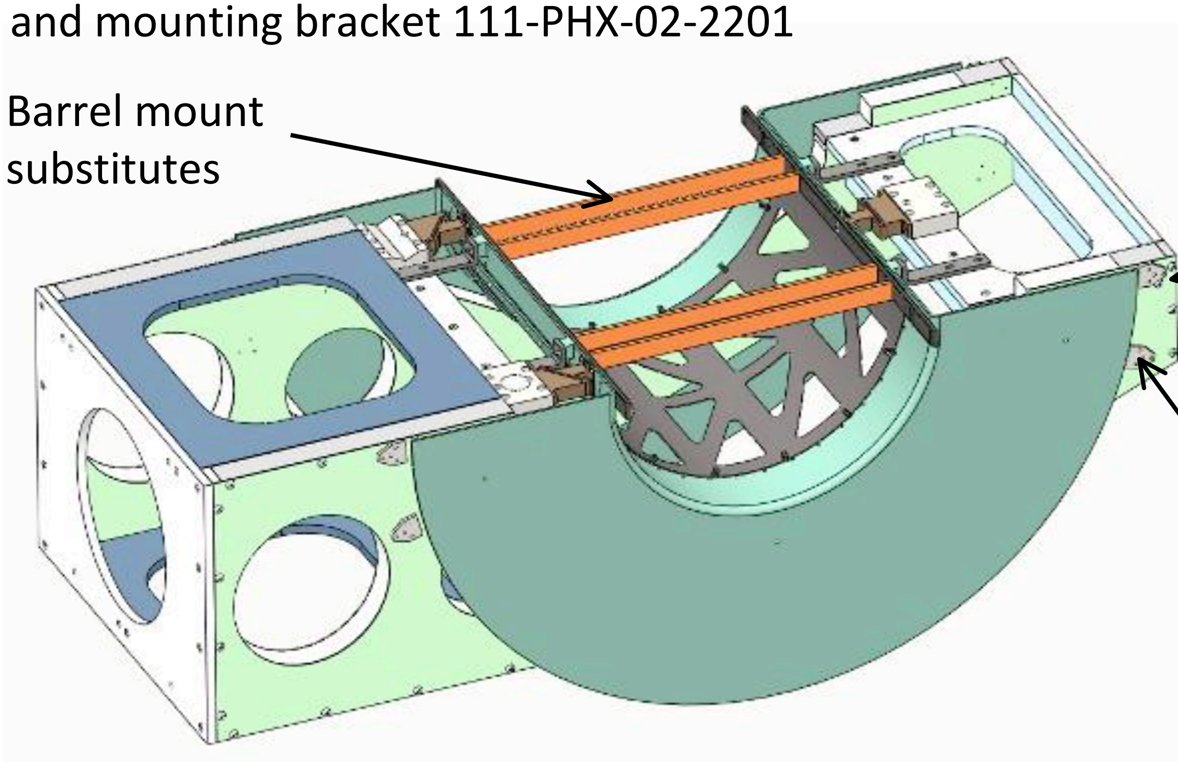


Attach space-frame assembly with layer 4 barrel mounts to BNL support structure using flexures

- The next step is to place the space-frame assembly, with the layer 4 barrel mounts attached (or the substitute layer 1 and 3 barrel mount - bars) into the BNL support structure
- The space-frame interfaces to the support structure using the three flexure mounts, 111-PHX-02-2065 and 2066, these are mounted to the space-frame with 1 extractable pin 111-PHX-02-2011 and 2 M3x.5 X 12 mm screws
- The addition of the flexure elastic seal 111-PHX-02-2034 and the seal retainer 111-PHX-02-2036 should be made
- The flexures interface to the BNL support structure with 2 extractable pins and 2 #10 screws
- The reason to keep the layer 4 barrel mount as a part of the space frame assembly at this point is to guarantee the spacing of the flexures is correct – top to bottom
- Next step is with the substitute layer 1 and 3 barrel mounts in place remove the layer 4 barrel mounts

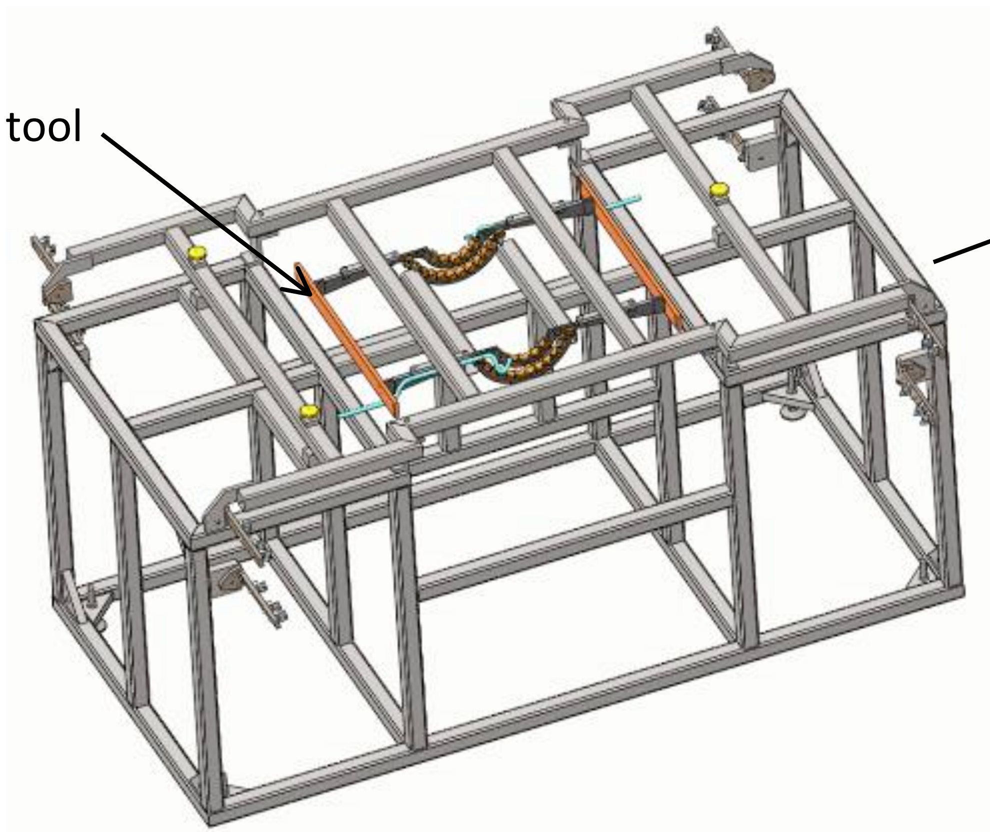
Attach space-frame to BNL support structure

- A stand will need to be fabricated to support the backside of the BNL support structure to allow for the larger diameter of the gas-enclosure and the Big-Wheels
- After the space-frame is interfaced to the BNL support structure remove the layer 4 barrel mounts
- Attach 4 Big-wheel plate mount spacers to the BNL support structure 111-PHX-02-2212 and mounting bracket 111-PHX-02-2201



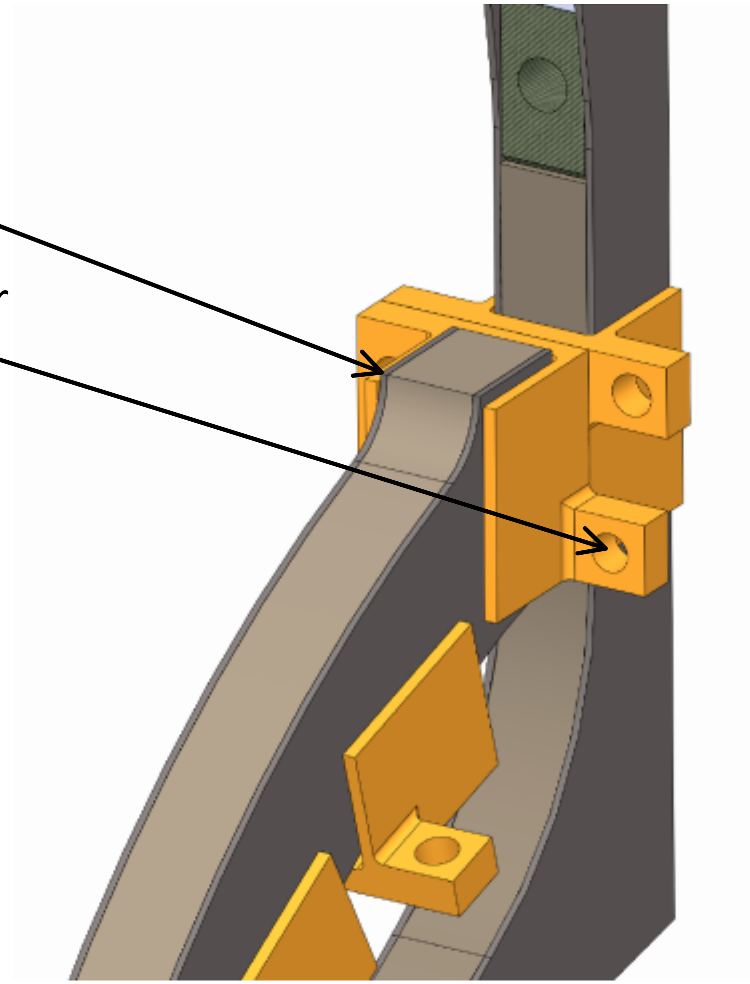
Locating barrel mounts for layers 1 & 2

- Attach layer 2 barrel mount tot back of layer 1 barrel mount
- Attach main-beam tooling bars to ends of layer 1 barrel mounts, this will set the correct spacing between them, use pin 111-PHX-02-2011 and M3 x 13 mm long screws
- Attach layer 2 barrel mounts to BNL layer 2 assembly stand, drawings 105-0222-168 & 105-0222-176
- Detach layer 1 transfer frame and layer 1 barrel mount from layer 2 barrel mounts
- Pay attention to assembly drawing 111-PHX-02-2004 for orientation of barrel mounts to +Y axis or UP



Barrel 2 to barrel 1 attachment points

- Screw attachment points between layer 1 and 2 barrel mounts, 2-56 screw with nut
- 2 locations at each end
- Attachment point to layer 2 assembly fixture, using a 2-56 screw and nut to layer 2 barrel mount

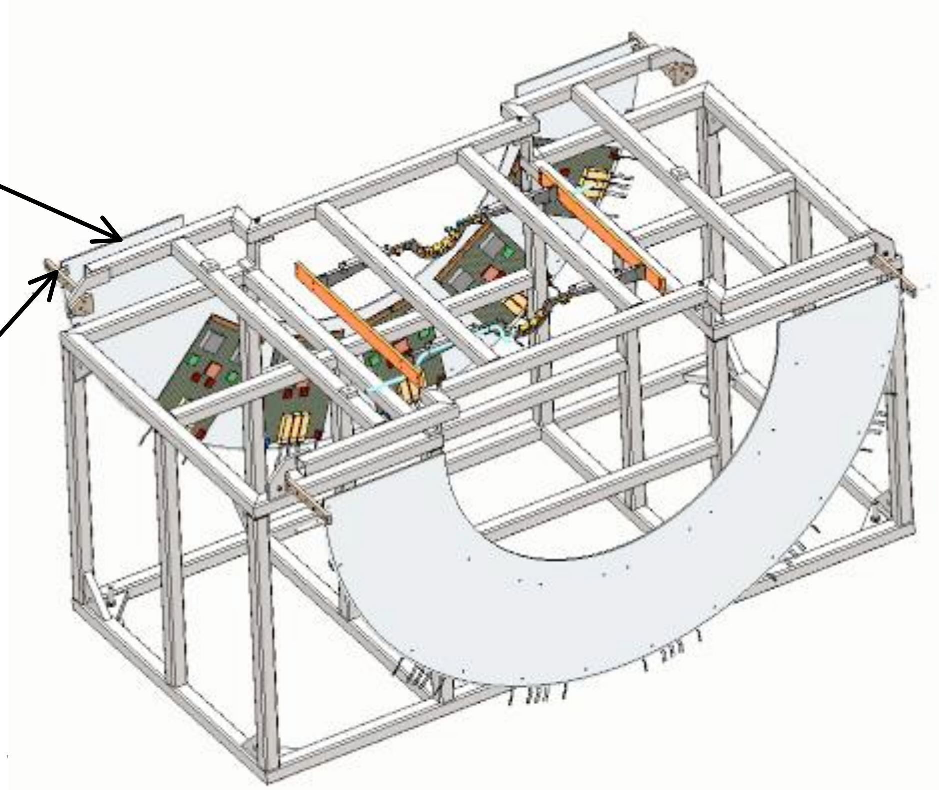


Locating layer 1 barrel mount in assembly stand

- After the layer 2 barrel mount has been set in its assembly stand, take the layer 1 barrel mount, with the main-beam tooling bars and transfer frame and set in the BNL layer 1 assembly fixture, BNL drawings 105-0222-165 & 105-0222-180 (station 1 transfer fixture)
- The main-beam tooling can remain with the barrel mounts
- The layer 1 Big-wheels, with SPIRO boards attached can be mounted to the assembly fixture using the four brackets on the transfer fixture

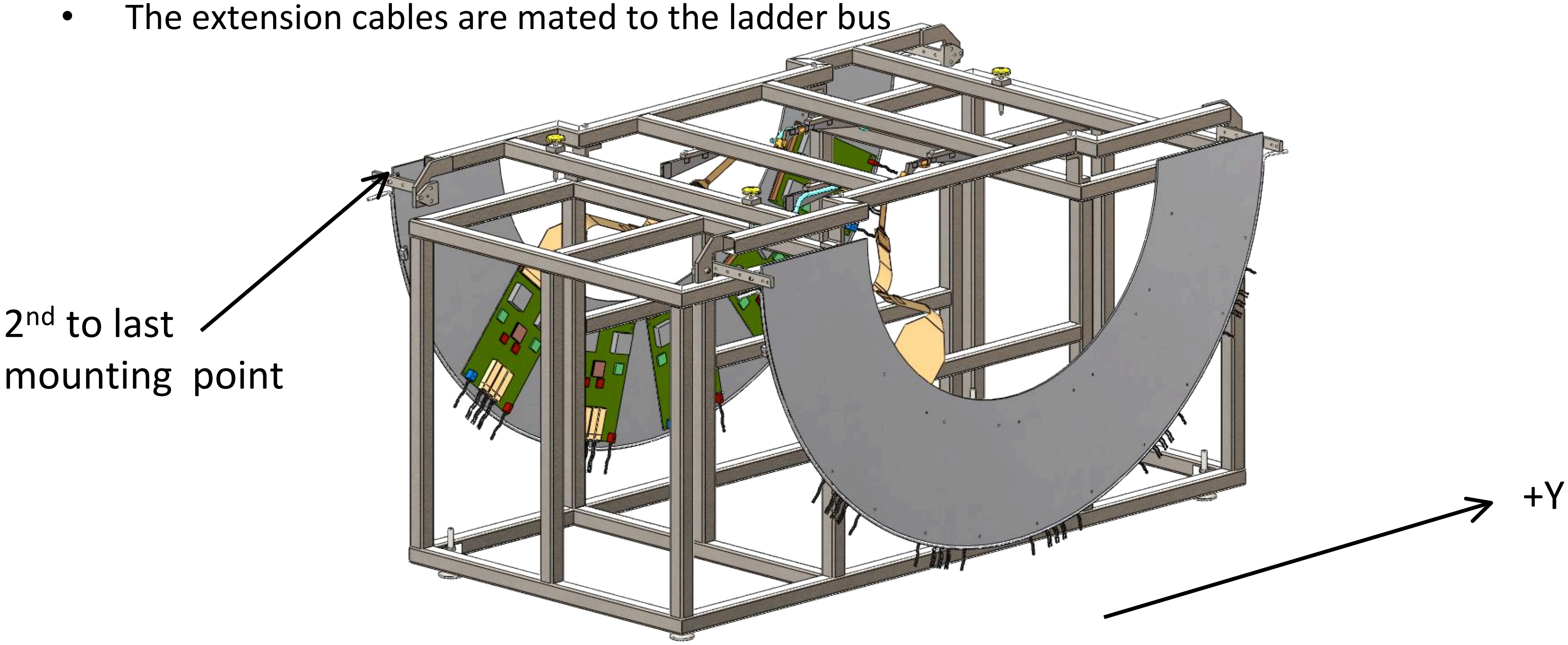
111-PHX-02-2204, plate 1,
note orientation

111-PHX-02-2201, qty 4



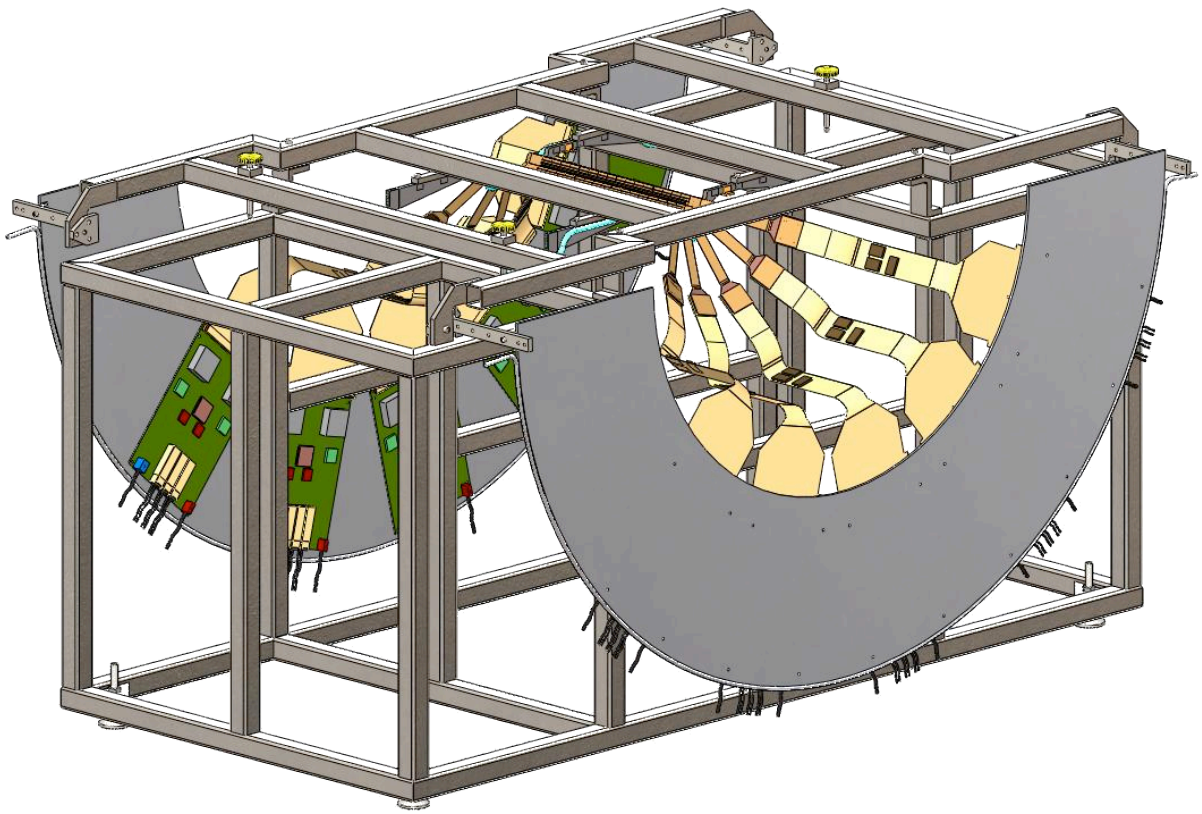
Barrel 1 Assembly (Pixel Stave Installation)

- 5 Pixel Staves (without extension cables) are installed on Barrel 1 Mount, using 2 2-56 X 3/16 PEEK screws at each end of stave (20 total for layer 1) staves are located to barrel mount via pins in barrel mounts
- SPIRO III boards are attached to Big-wheel using 4, 4-40 X 3/8” screws, 20 per plate
- Station 1 Big-wheel is located at second to last mounting point on support brackets
- Extension Cable 111-PHX-02-2039 connections are made to the Spiro Cards
- The extension cables are mated to the ladder bus



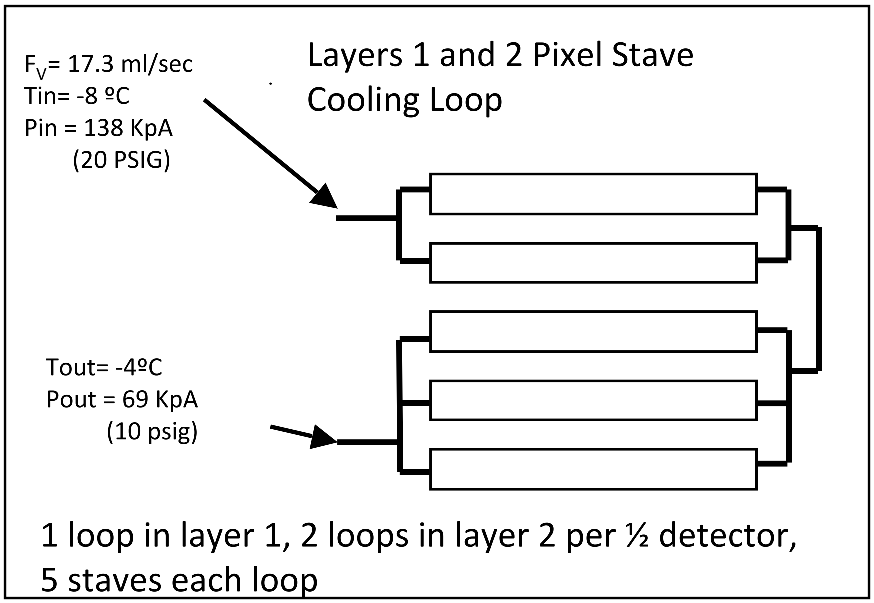
Barrel 1 Assembly (Cooling Tube Installation)

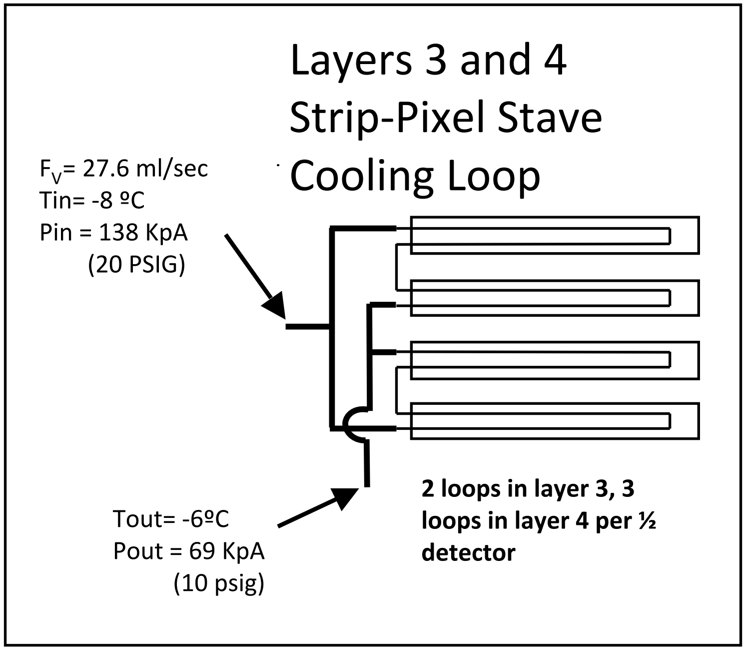
- After all Staves are installed, 1/8” ID Tygon Cooling Tubes are connected as per Don Lynch’s cooling diagram (see next slide) the bottom ladder is the inlet and should have two ladder in parallel - then tied in series to the upper three ladders tied in parallel to an outlet



Don Lynch's VTX cooling circuits

New internal loop designs which meet design requirements

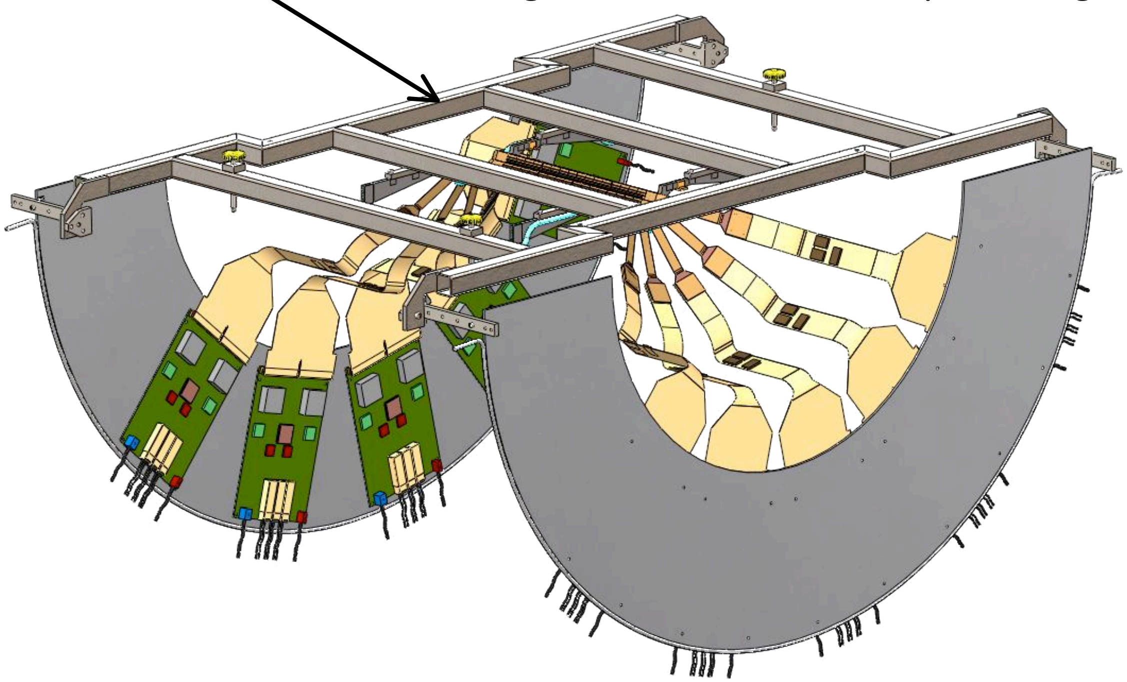




Main Assembly Sequence (Barrel 1 Transport)

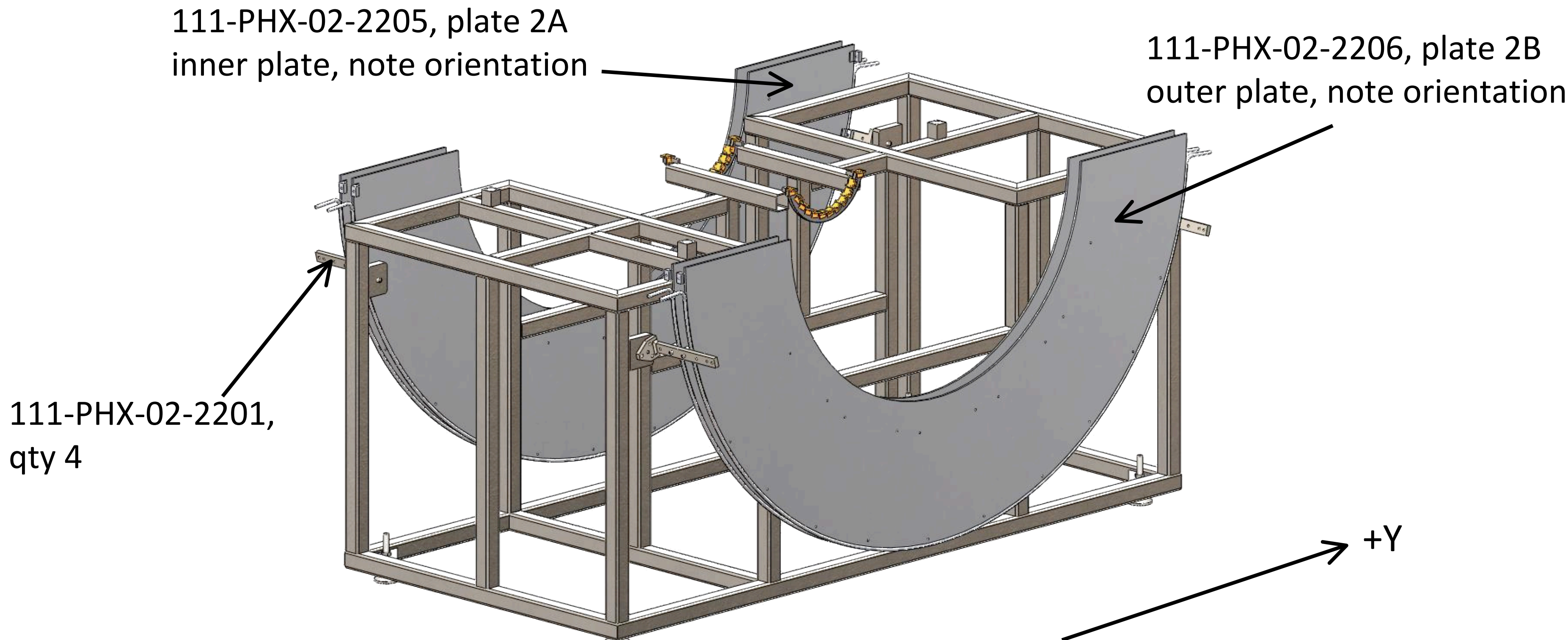
- Barrel 1 Assembly can remain in the Assembly transport frame until it is removed to connect with the layer 2 assembly
- The upper portion of the Barrel 1 Assembly Fixture serves as the Barrel 1 & 2 Assembly Transport Frame

*In this view the main-beam tooling has been removed
Big-wheels located in 4th position going out in Z



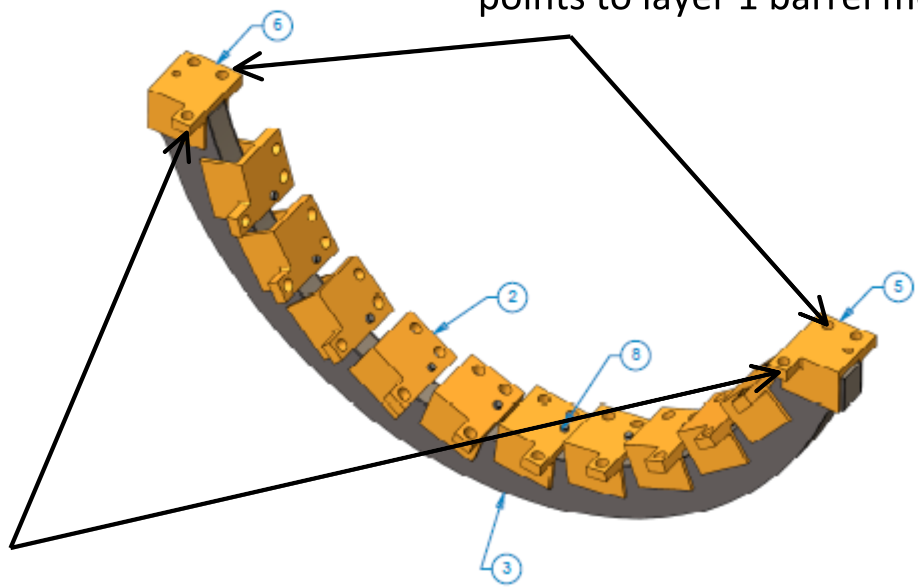
Barrel 2 Assembly (Barrel Mounts)

- Barrel 2 Big-wheels with SPIRO cards attached (not pictured) are installed in the Barrel 2 Assembly Fixture, again using 4-40 X 3/8 inch screws
- Barrel 2 Mounts are installed in the Barrel 2 Assembly fixture, BNL drawings 105-0222-168 & 105-0222-176, reference drawing 111-PHX-02-2005, 111-PHX-02-2012 – performed in slide 3
- This assembly will mount off the backside of the layer 1 barrel mount assembly
- Big-wheels – with SPIRO boards attached, are mounted to assembly stand (see slide 12)



Locating Barrel Mount to Assembly Stand

4 screw hole locations are attachment points to layer 1 barrel mounts.

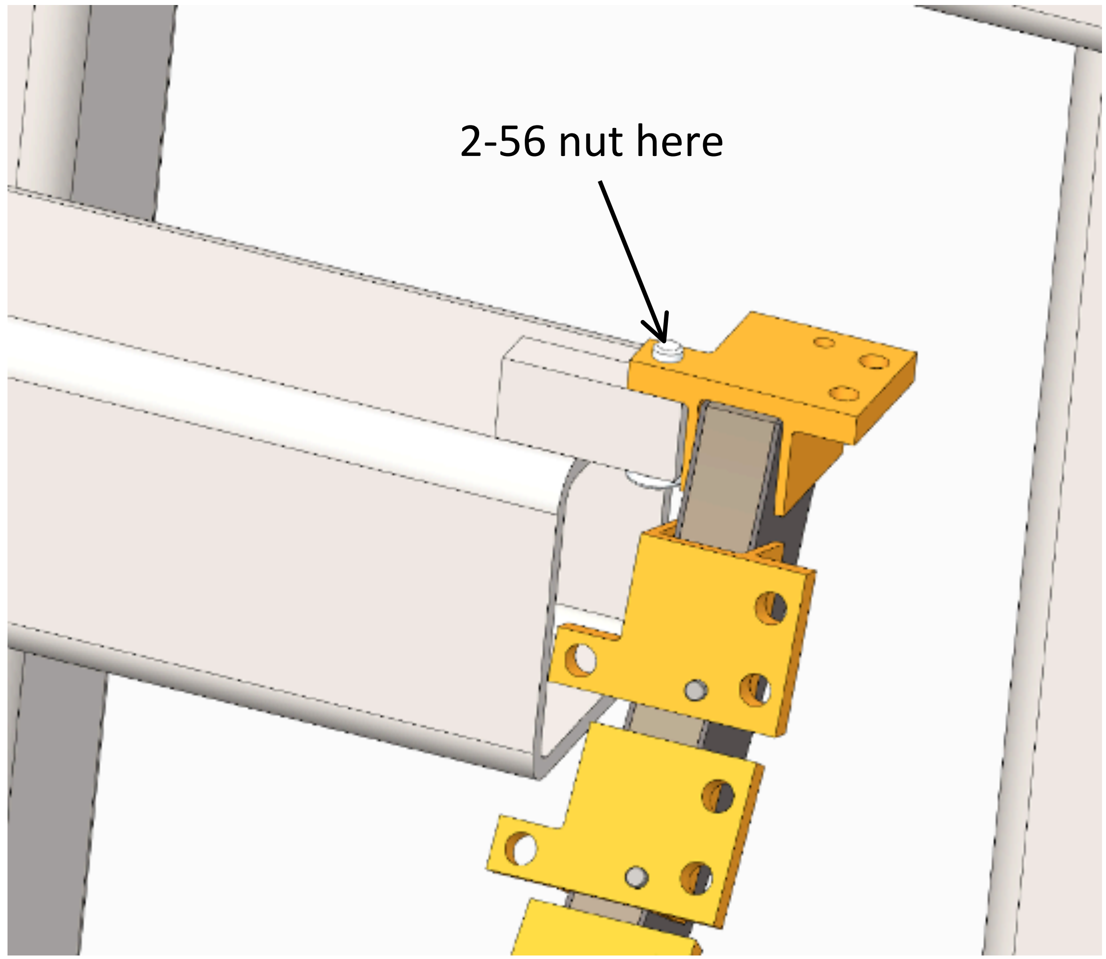


Mounting location to assembly stand using 2 2-56 X ½ inch with nut. **
NOTE: it is possible that the three 2.18mm diameter holes in the two mounting blocks should be opened up to 3/32 inch diameter. These mounting points face towards the inside.

-1 RIGHT HAND

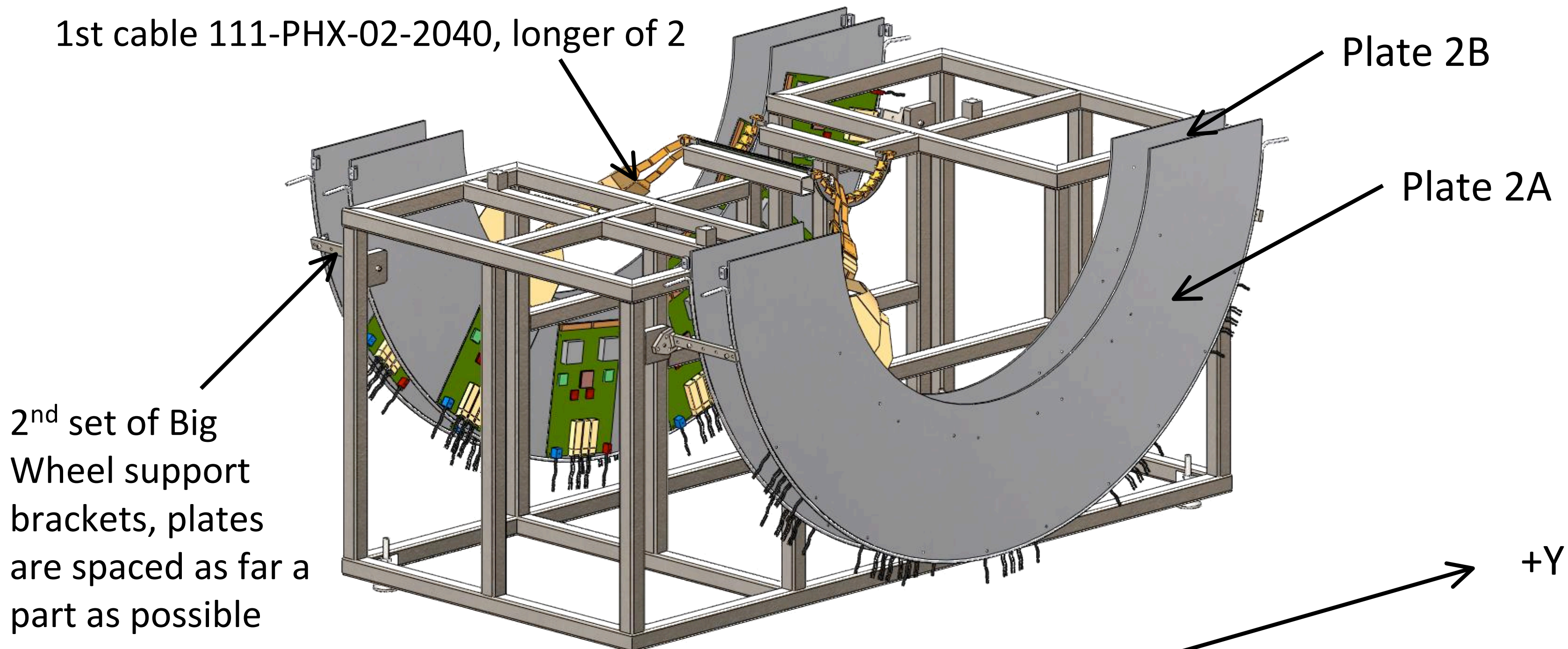
Locating Barrel Mount to Assembly Stand

View of layer 2 barrel mount attached to HYTEC assembly stand, NOTE the #2-56 screw needs to be at least ½ inch in length in order to secure with a nut. The three holes in this block, should also be opened up to 3/32" diameter, as previously mentioned.



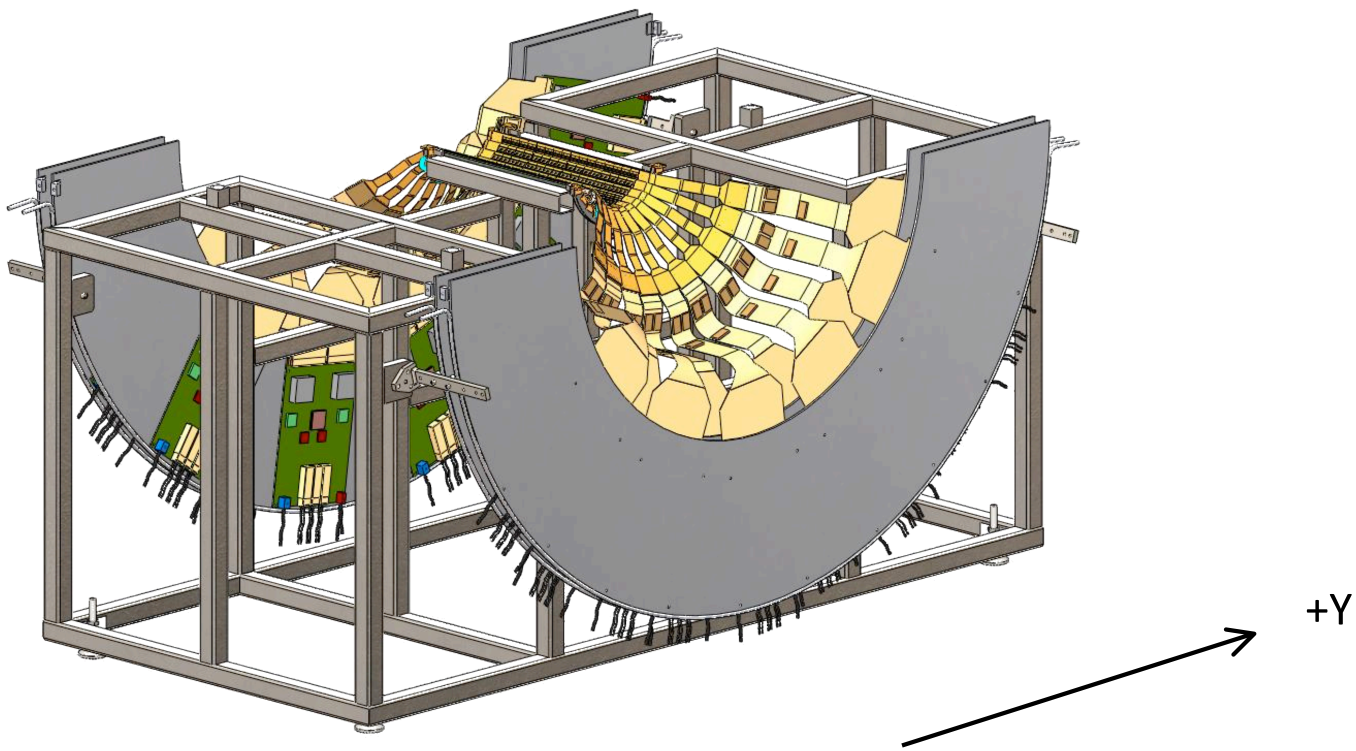
Barrel 2 Assembly (Stave Installation)

- Pixel Stave are installed in Barrel 2 Mounts, using pins in barrel mounts and 2 2-56 X 3/16 inch screws, 40 screws total, McMaster-Carr part# 91772A076
- Extension Cables are attached between the Spiro Cards and the pixel bus, extension cables from every other stave goes to the same Big-wheel, the two Big Wheels should be kept apart as much as possible using their support brackets (1st and last position)
- The Big-wheels are mounted further apart to facilitate extension cable connection to the SPIRO III cards, cables 111-PHX-02-2040 and 111-PHX-02-2041



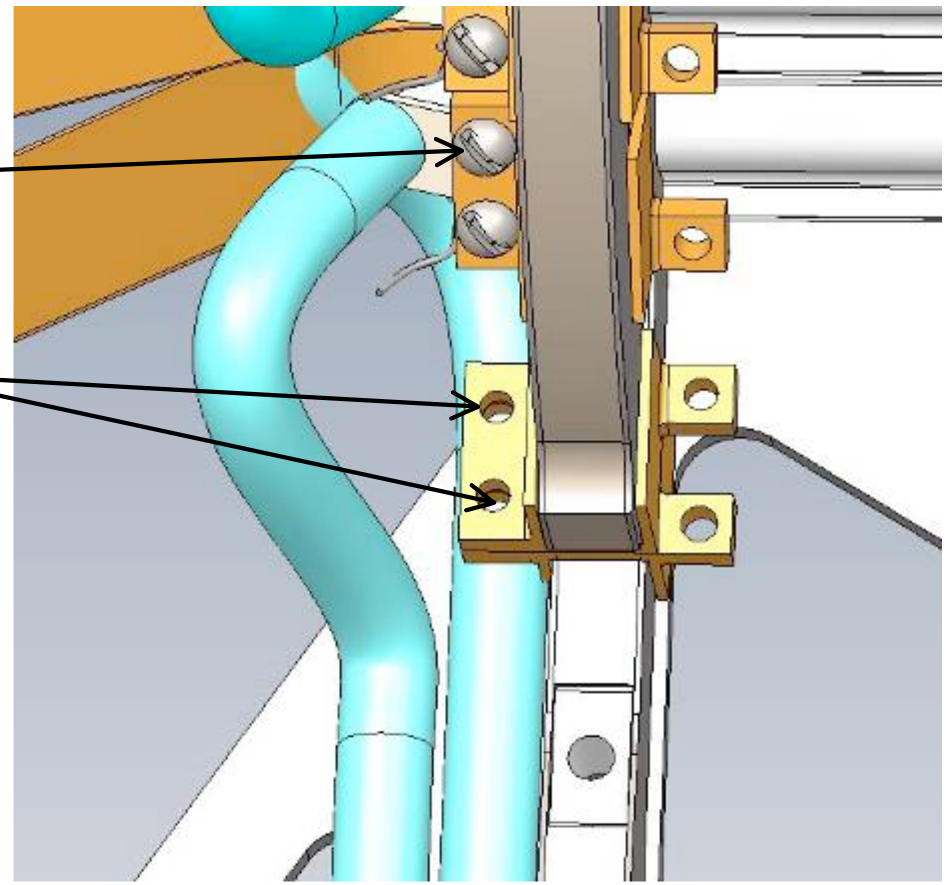
Barrel 2 Assembly (Cooling Tube Installation)

- Using a foam cylinder may aid the bending of extension cables
- The Big-wheels are moved to their final positions on brackets
- After all Staves are installed, Cooling Tubes are connected, D. Lynch circuit description
- Big-wheels are moved closed together on brackets, 2nd and 3rd location going out in Z



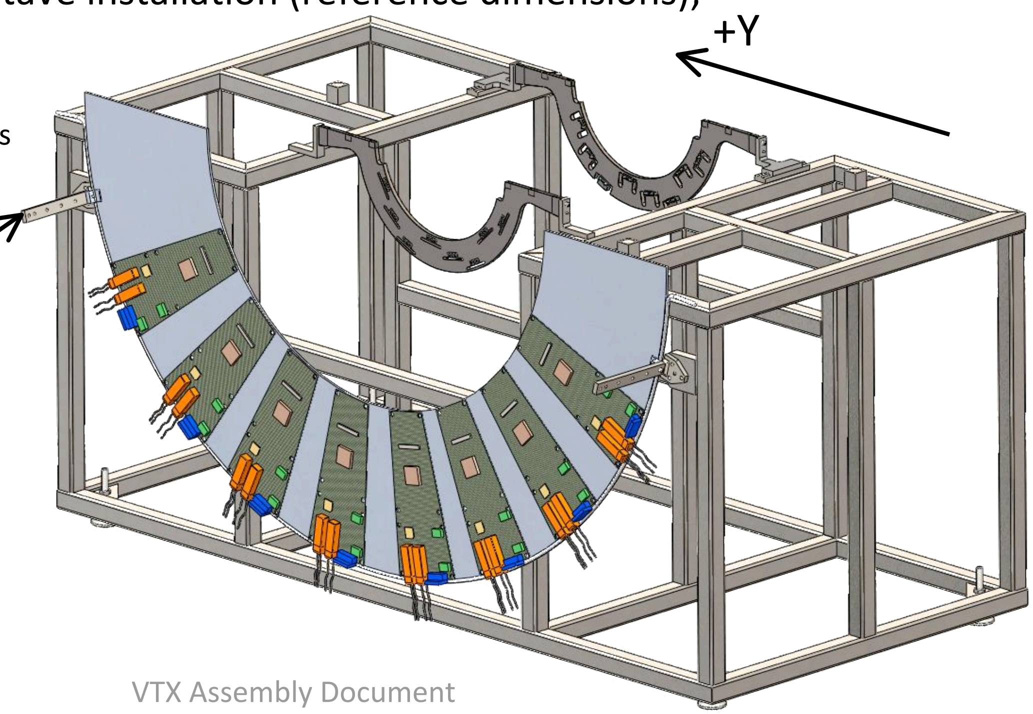
Detail view of ladder attachment, layer 2

- Detailed view of ladder attachment to layer 2 barrel mount:
  - 2-56 screws attaching ladder to barrel mount
  - Location for 2-56 screws (2) attaching layer 2 barrel mount tot layer 1 barrel mount



Barrel 3 Assembly (Barrel Mounts)

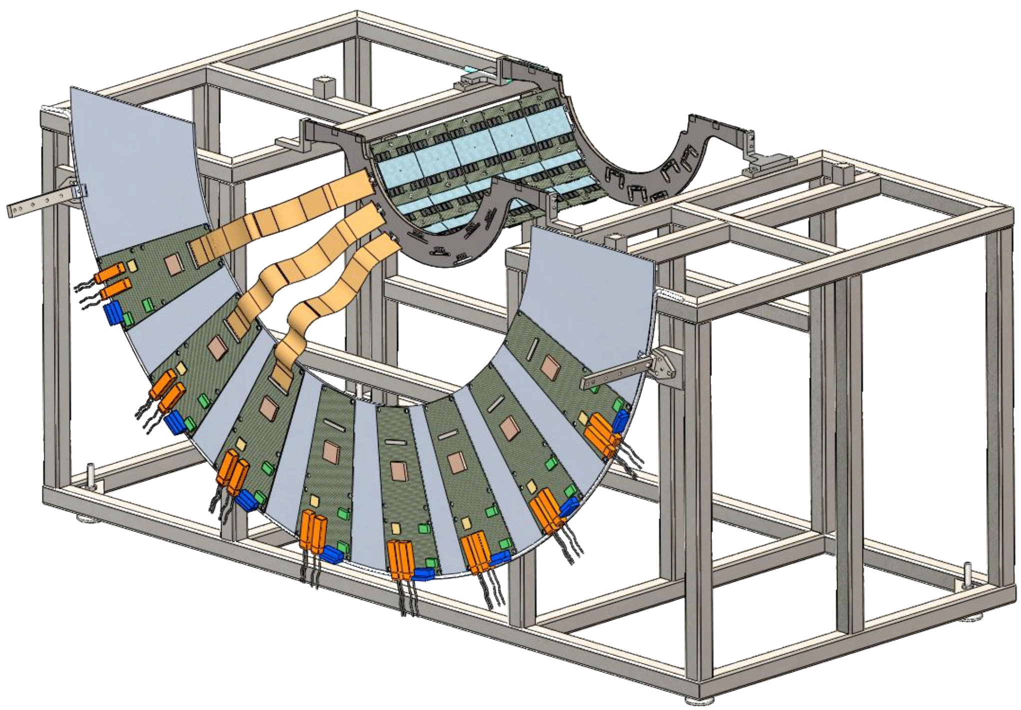
- Barrel 3 Big-wheel with electronic LDTB cards attached is installed in the Barrel 3 Assembly Fixture, attached to closest position to assembly fixture. Screw. LTDB board is attached to the Big-Wheel by 8, 8-32 X 3/8 inch screw
- Barrel 3 Mounts are installed in the Barrel 3 Assembly fixture, 105-0222-167, using 1 M3x.5 X 13 mm length and 2 111-PHX-02-2011 extractable pins at each end with a M3x.5 X 13mm long screw
- The Barrel Mount opposite of the Big-wheel is initially mounted out far enough to allow the hose barbs to clear during Stave installation (reference dimensions);
  - Stave = 331.5 mm
  - Tube & hose barb = 12.75 mm
  - Initial spacing between mounts 344. 5 mm minimum



3rd set of 2 Big Wheel support brackets, 111-PHX-02-2201, BW #3 111-PHX-02-2207

Barrel Assembly (Stave Installation)

- Strip Staves are installed in Barrel 3 Mounts in a circular pattern
- Extension Cables are attached to the LDTB electronics cards by sliding them through slots in the Barrel 3 Mount
- 2 Pins 111-PHX-02-2011 and one M3x.5 X 16 mm screw, hold the Stave in alignment with the Barrel Mount on the Big-wheel side
- Opposite end of stave is supported with one long M3x.5 threaded rod with nut

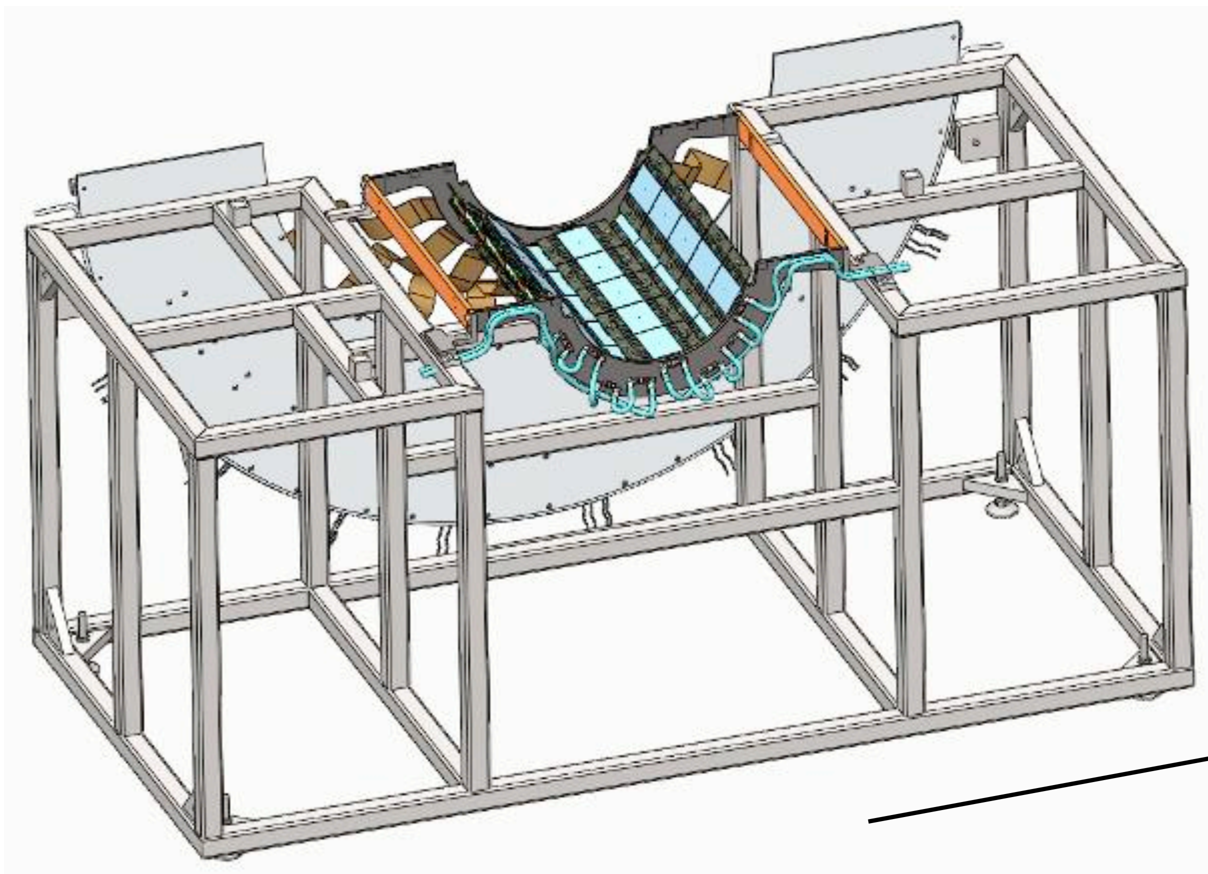


Barrel 3 Assembly (Cooling Tube Installation)

- Once all the Staves are installed the Barrel Mount on the cooling tube side is moved in and attached to the Staves
  - This will be done using the screws that are long enough to reach the Stave through the Barrel Mount
    - Slowly move the barrel mount towards the ends of the stave
  - When the barrel mount is brought in contact with the end of the stave, 2 111-PHX-02-2011 pins are added to keep this end of the stave in alignment with the barrel mount, the long M3x.5 threaded rod is replaced with 2 pins and a M3x.5 X 12. mm screw
- After the Barrel Mount is secure the cooling hoses are attached between the Staves, as per Don Lynch's cooling circuit on slide 6. Remember the inlet is at the bottom
- Verify the correct barrel mount to barrel mount spacing using the main-beam tooling bars, initially laying them on the face that the mid-plane lateral stiffeners would attach to 111-PHX-02-2019

Barrel 3 assembly

- It is possible to pin the main-beam tooling bars through the assembly stand bracket to check barrel mount to barrel mount spacing



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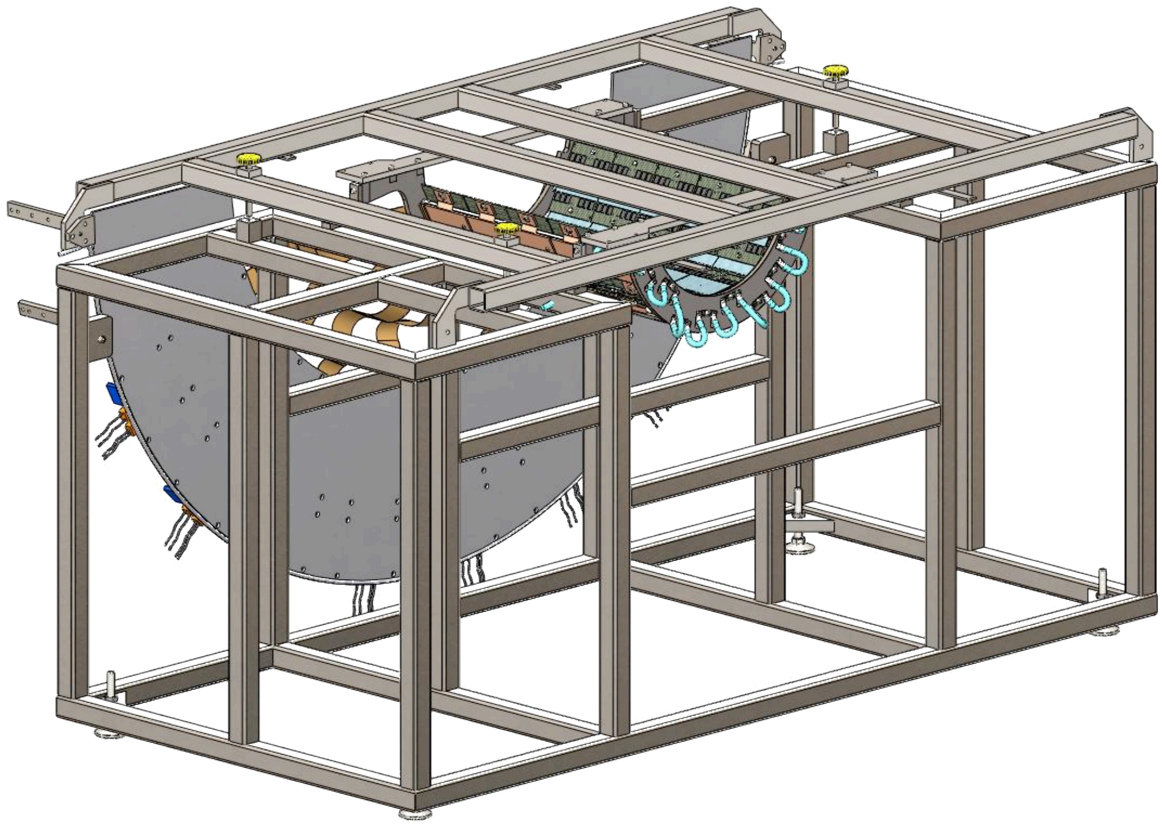
Barrel 3 Assembly (transport frame added)

- Addition of BNL Barrel 3-4 transport frame, BNL-105-0222-185, 3 ¼-20 thumb screws are needed to set the height of the transport frame above the assembly stand
- Remove main-beam tooling if still in use
- Big-wheel should be mounted to inner most position on brackets



Barrel 4 Assembly (Barrel Mounts)

- Barrel 4 Big-wheel with electronics cards attached is installed in the Barrel 4 Assembly Fixture
- Barrel 4 Mounts are installed in the Barrel 4 Assembly fixture
- The Barrel Mount opposite of the Big-wheel is initially mounted out as far as possible on slider blocks, to allow the hose barbs to clear during Stave installation
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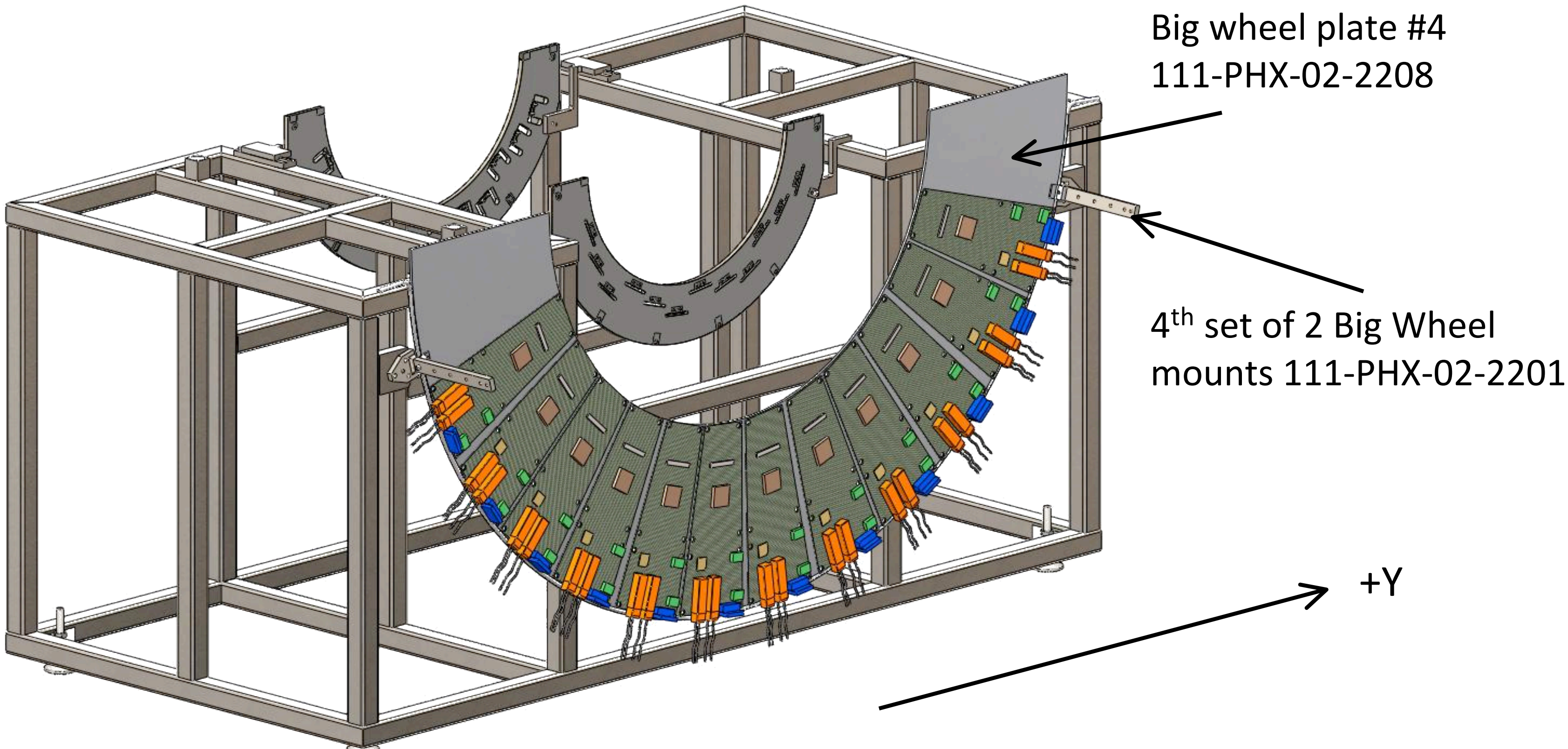
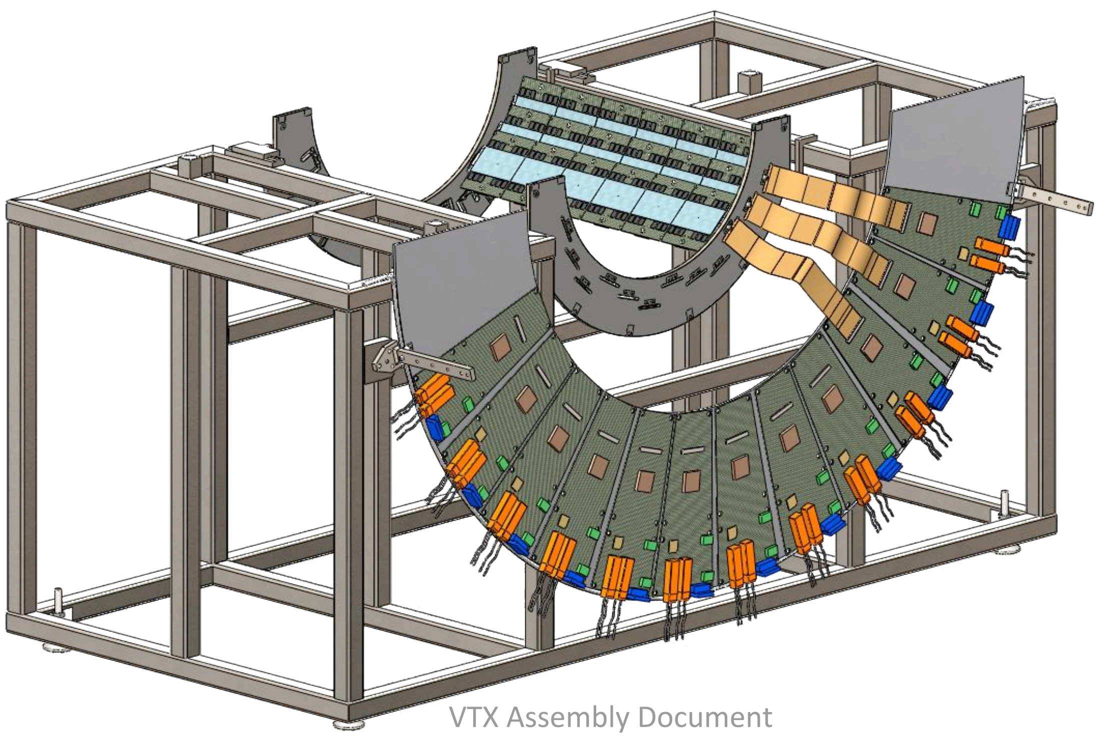


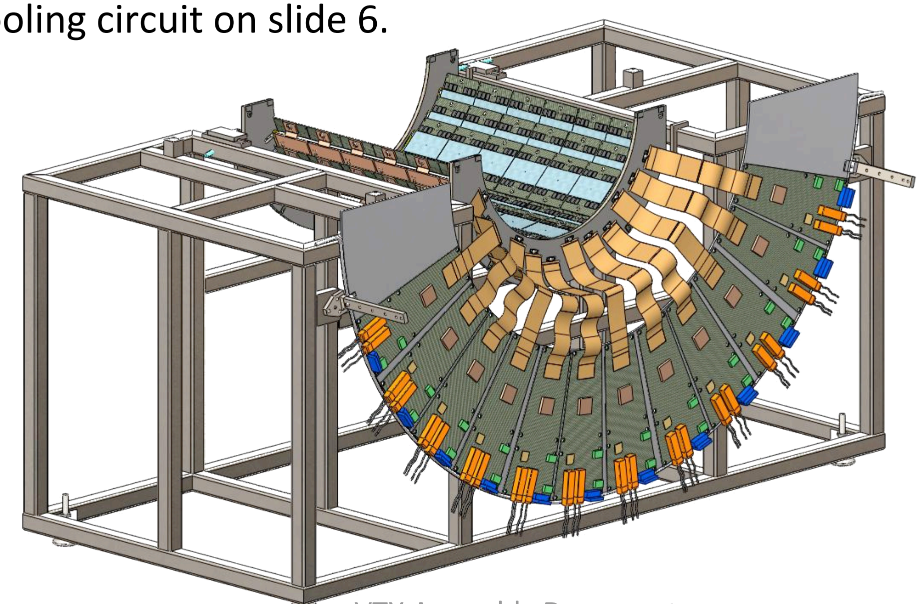
Barrel 4 Assembly (Stave Installation)

- Strip Staves are installed in Barrel 4 Mounts
- Extension Cables are attached to the electronics cards by sliding them through slots in the Barrel 3 Mount
- 2 Pins 111-PHX-02-2011 and one M3x.5 X 12 mm screw, hold the Stave in alignment with the Barrel Mount on the Big-wheel side
- Opposite end of stave is supported with one long M3x.5 threaded rod with a nut
- Big-wheel mounted to inner most position on bracket



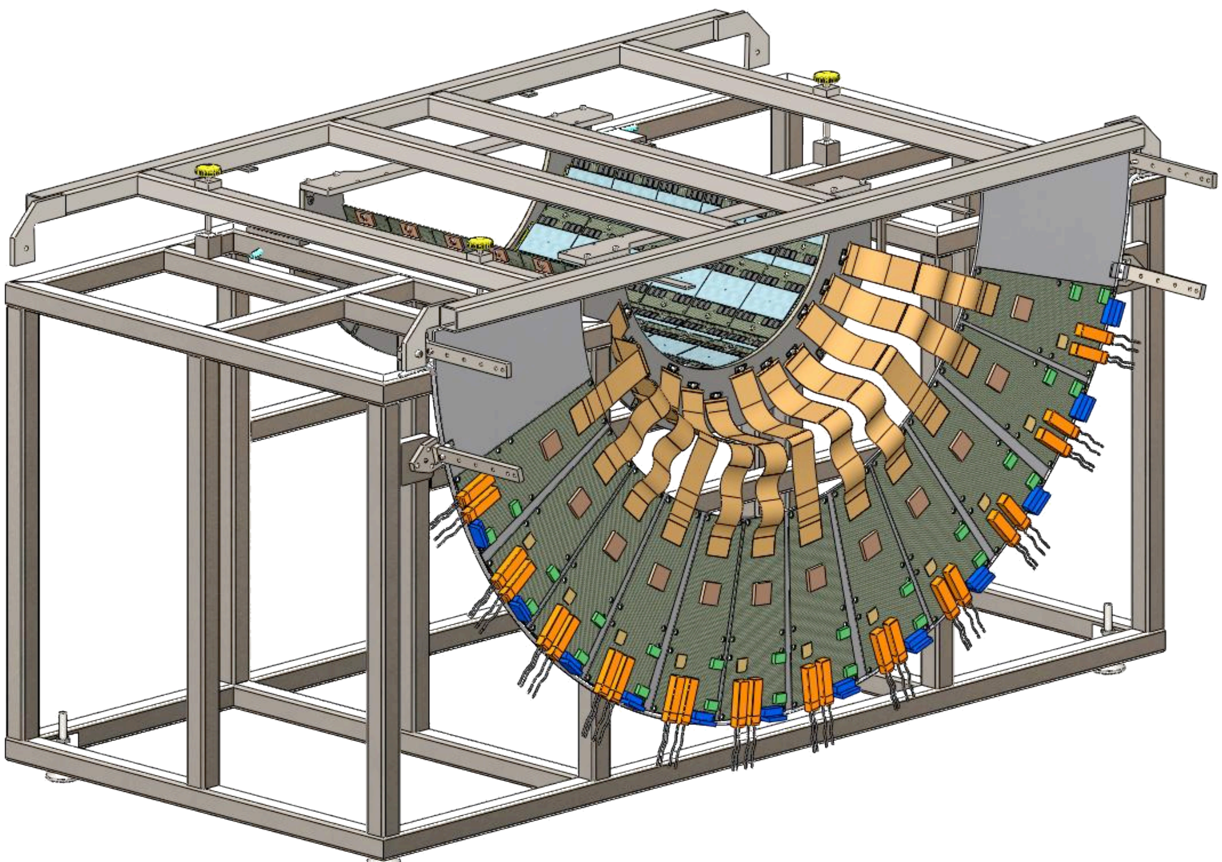
Barrel 4 Assembly (Cooling Tube Installation)

- Once all the Staves are installed, the Barrel Mount on the cooling tube side is moved in and attached to the Staves
  - This will be done using threaded rod with nuts that are long enough to reach the Stave through the Barrel Mount
    - Slowly move the barrel mount towards the ends of the stave
  - When the barrel mount is brought in contact with the end of the stave, 2 111-PHX-02-2011 pins are added to keep this end of the stave in alignment with the barrel mount, the long M3x.5 threaded rod is replaced with a M3x.5 X 12 mm screw
- After the Barrel Mount is secure the cooling hoses are attached between the Staves, as per Don Lynch's cooling circuit on slide 6.



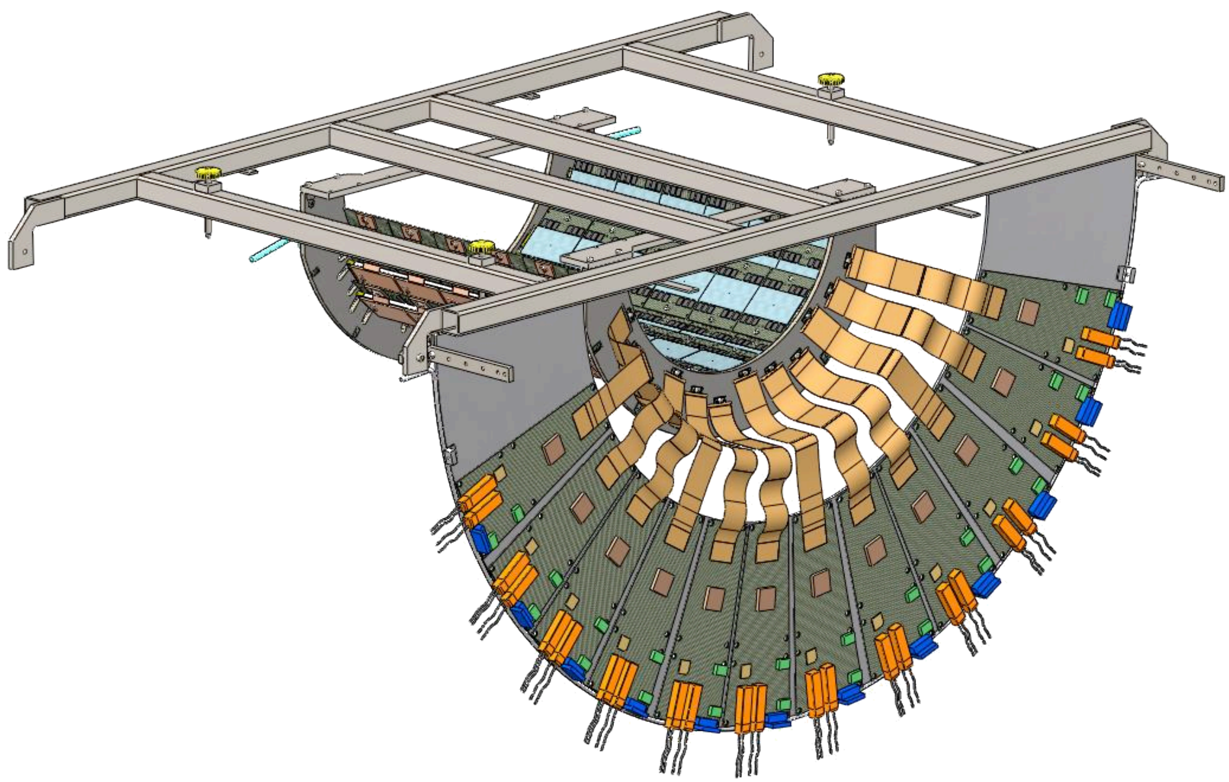
Barrel 4 Assembly (Transport Frame)

- Addition of the 2nd BNL Barrel 3-4 transport frame, BNL-105-0222-185, 3 ¼-20 thumb screws are needed to set the height of the transport frame above the assembly stand



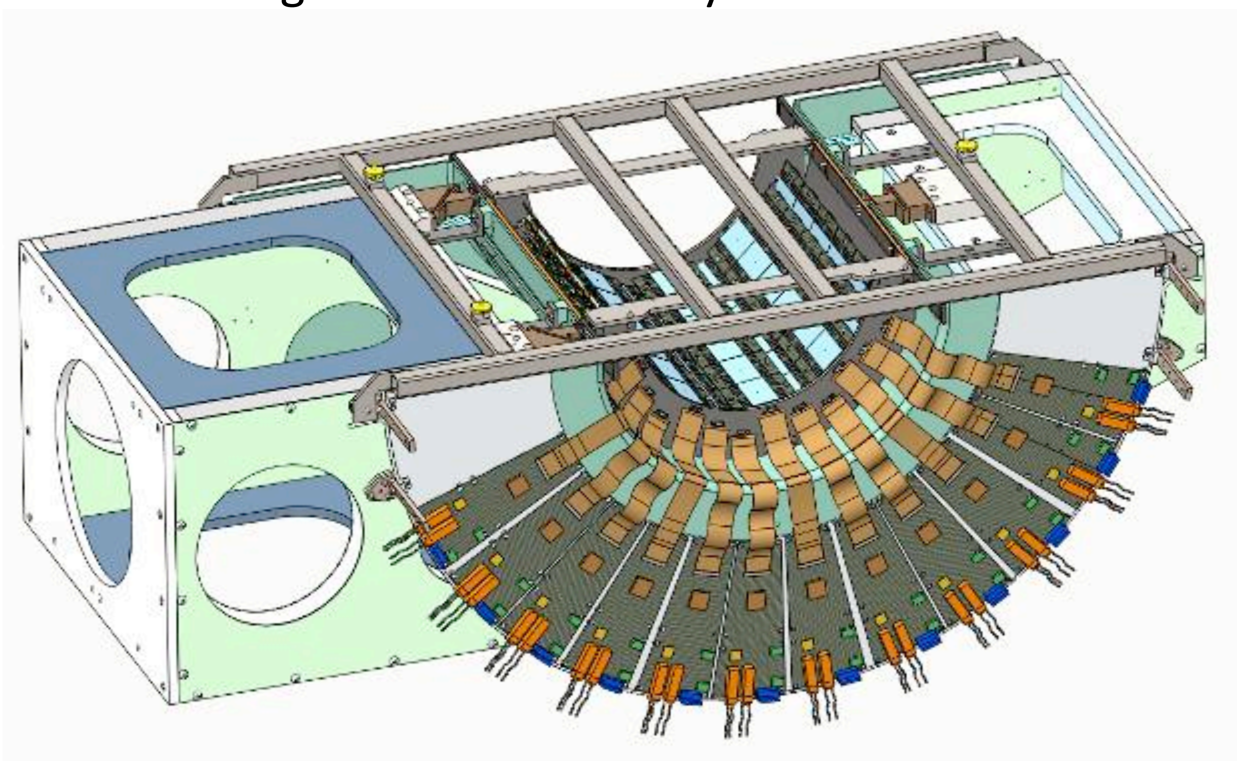
Main assembly sequence layer 4

- Barrel 4 in transport frame ready to install in BNL support structure
- Same transport frame will be used to install layer 3 in the BNL support structure

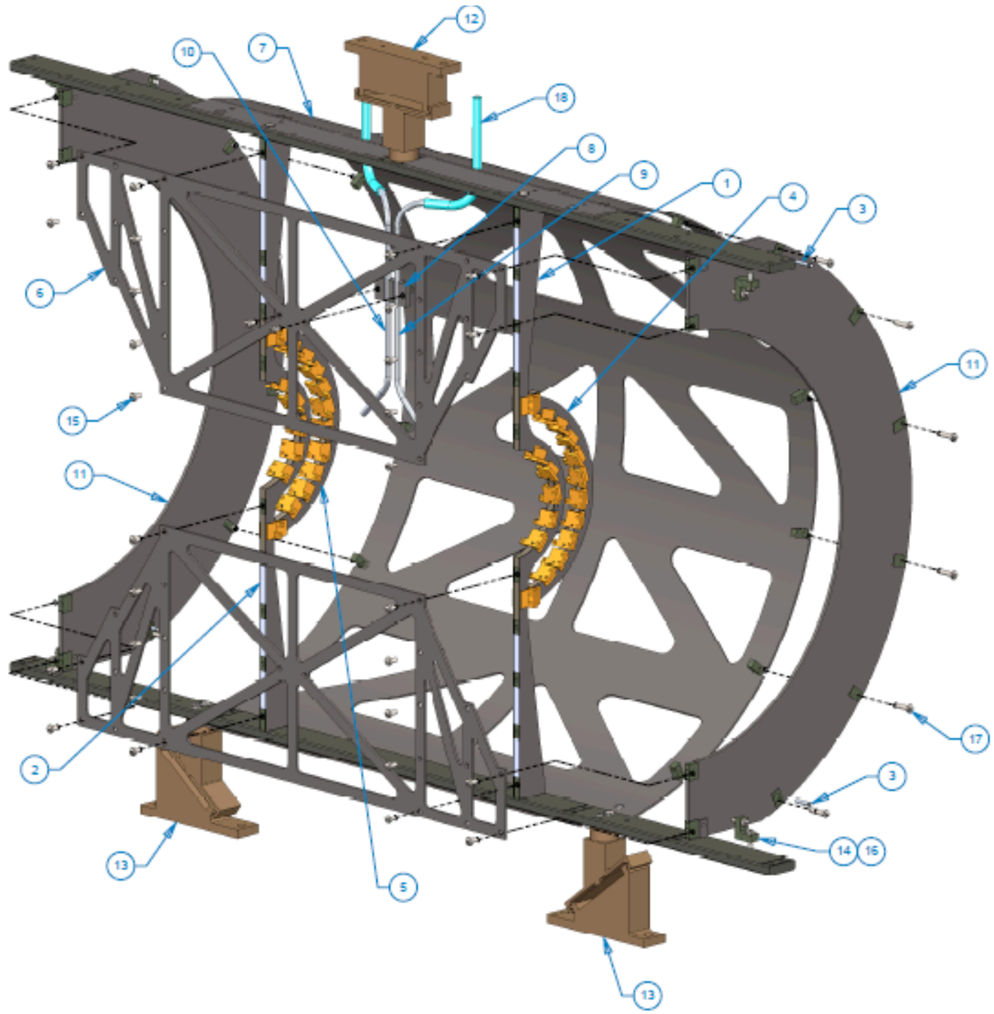


Main assembly sequence layer 4

- Barrel 4 is placed into the BNL support structure and attached to the space-frame
- Adjustment screws interface with the support structure's kinematic interface to provide accurate placement (height)
- Transfer attachment of Big-wheel to assembly structure



Attachment points layer 4 to space frame

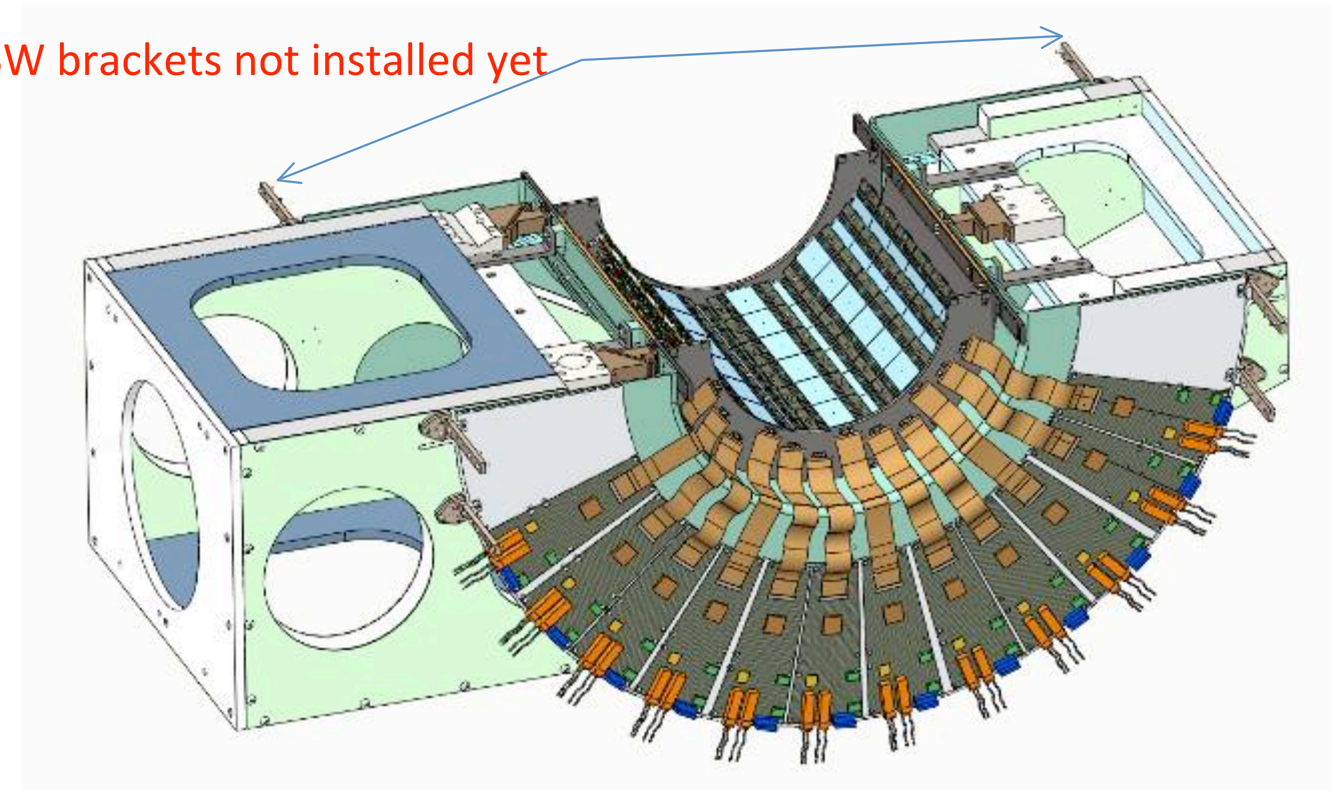


Each layer 4 barrel mount attaches as shown in drawing 111-PHX-02-2004 -
2 - right angle brackets # 14 to main-beam
4 - M3x.5 X 10 mm screws #17
2 - extractable pins #3
6 - M3x.5 X 12 mm screws #16
NOTE it may be necessary to disconnect some of the LTDB cables from the Big-wheel in order to install some of the 13 mm long screws

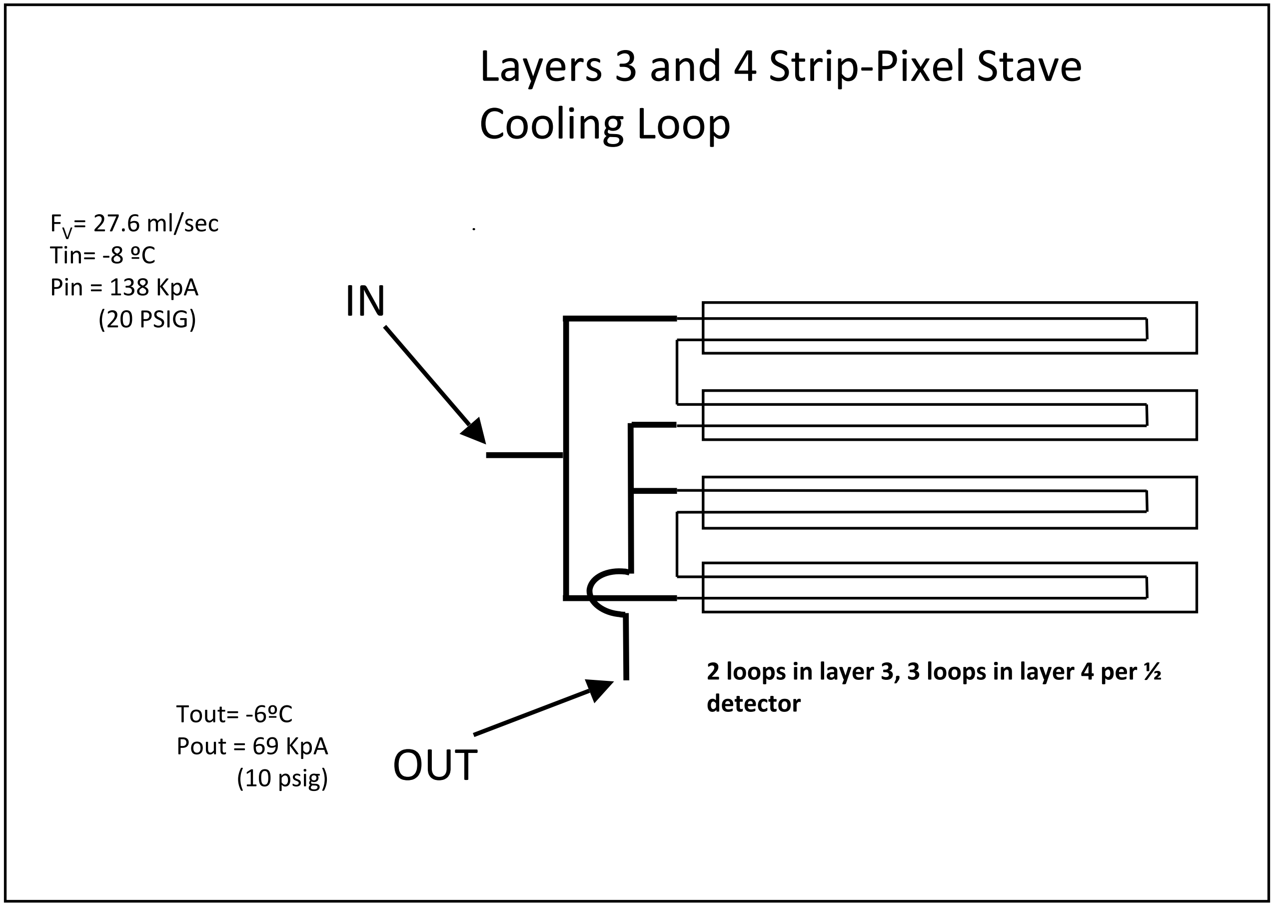
Barrel 4 transport frame removed

- Transport Frame is removed from the Barrel 4 Assembly
- Cooling Tube connections through the Gas Enclosure are made, according to Don Lynch's cooling circuit plan, see next side, 2 sets of 4 ladders

BW brackets not installed yet

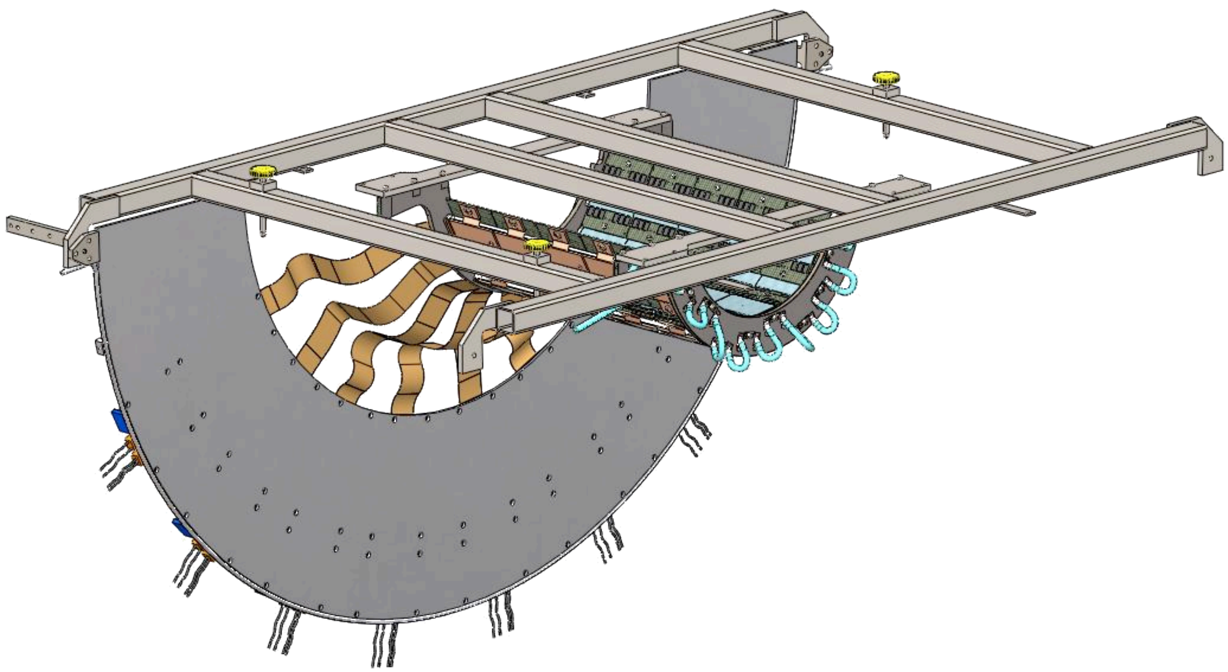


New internal loop designs which meet design requirements, D. Lynch



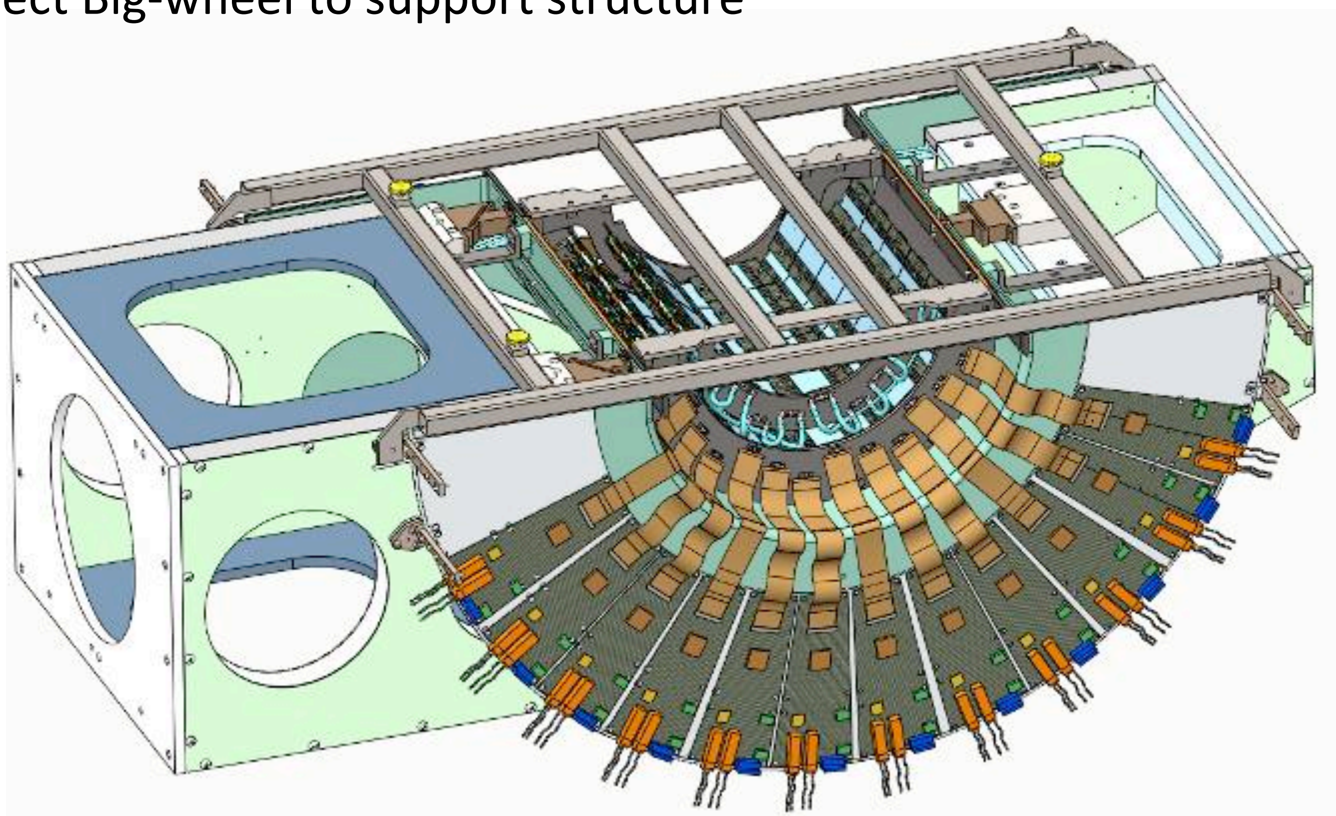
Main assembly sequence layer 3

- Transportation Frame is used to move the Barrel 3 Assembly from its Assembly Fixture to the BNL support structure, after removal from layer 4
- Transport frame attached to layer 3 barrel mount using 12 M3x.5 X 6 mm



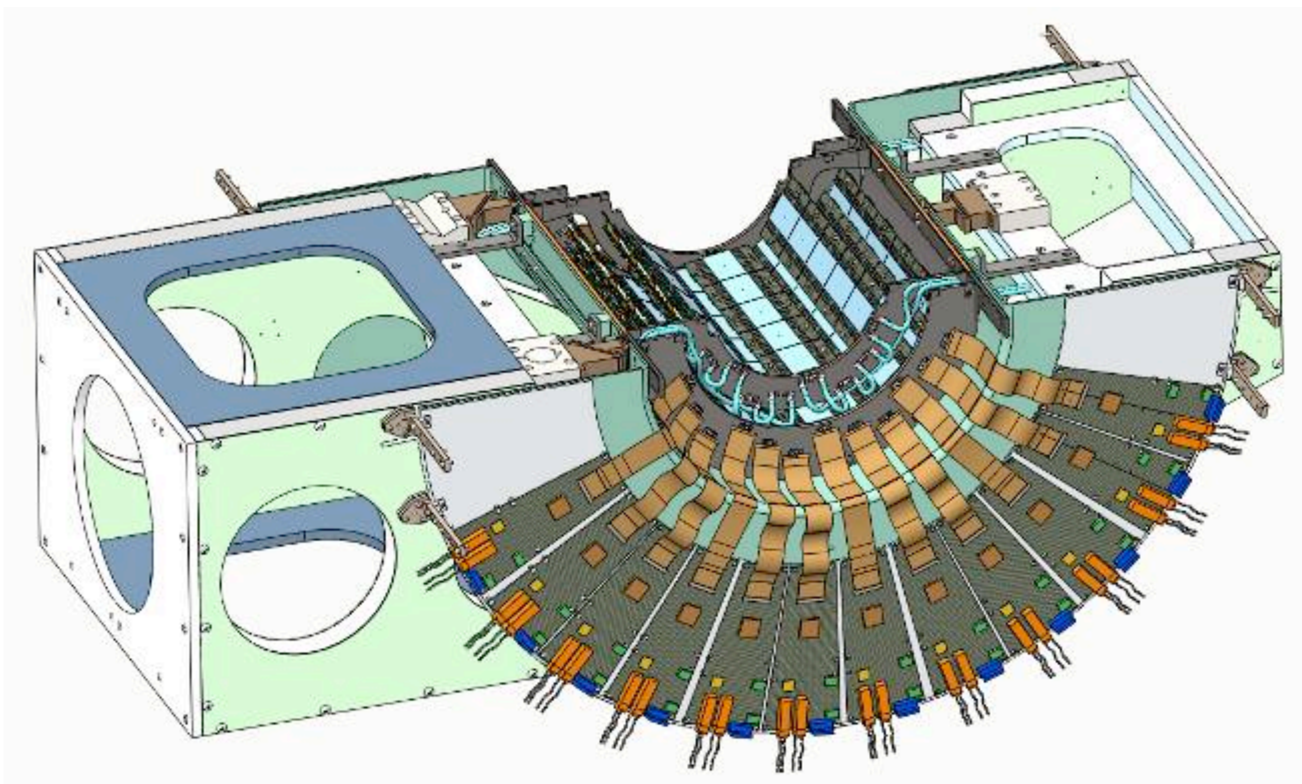
Main assembly layer 3

- Barrel 3 is placed into the BNL support structure
- Barrel 3 attaches to the main-beams using 4 extractable pins and 4 M3x.5 X 12 mm long screws
- Connect Big-wheel to support structure



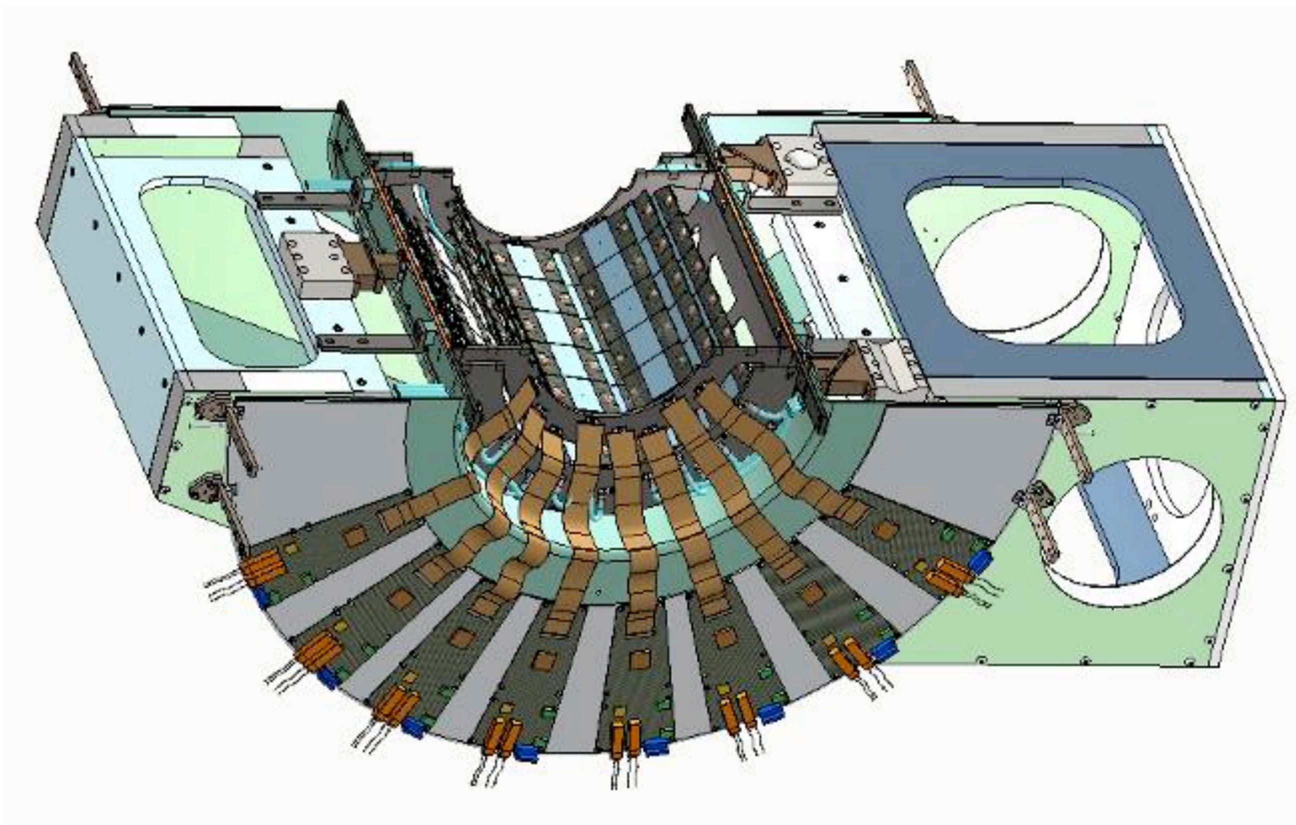
Barrel 3 transport frame removed

- Transport frame is removed from the barrel 3 assembly
- Cooling lines are connected according to Don Lynch' cooling circuit diagram
- Again upper Big-wheel brackets (4) are not present



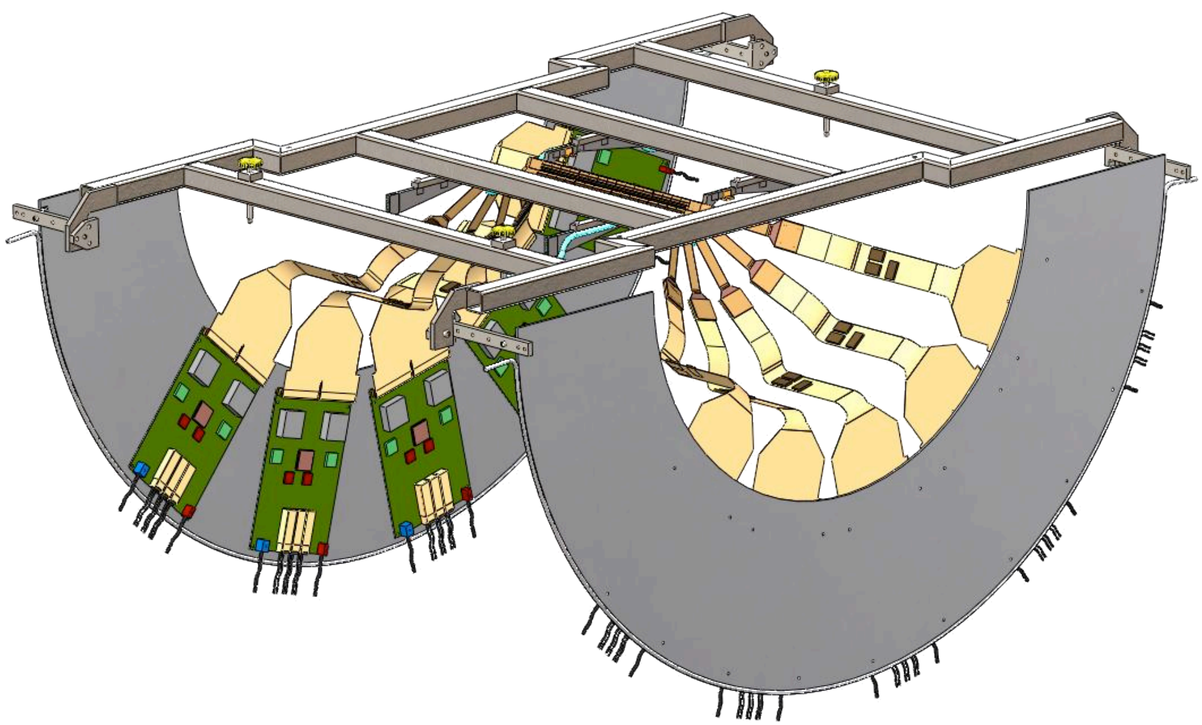
Layer 3 view showing Big-wheel

- This view of layer 3 for the layer 3 Big-wheel side
- NOTE you will only have the lower two Big-wheel support brackets in place



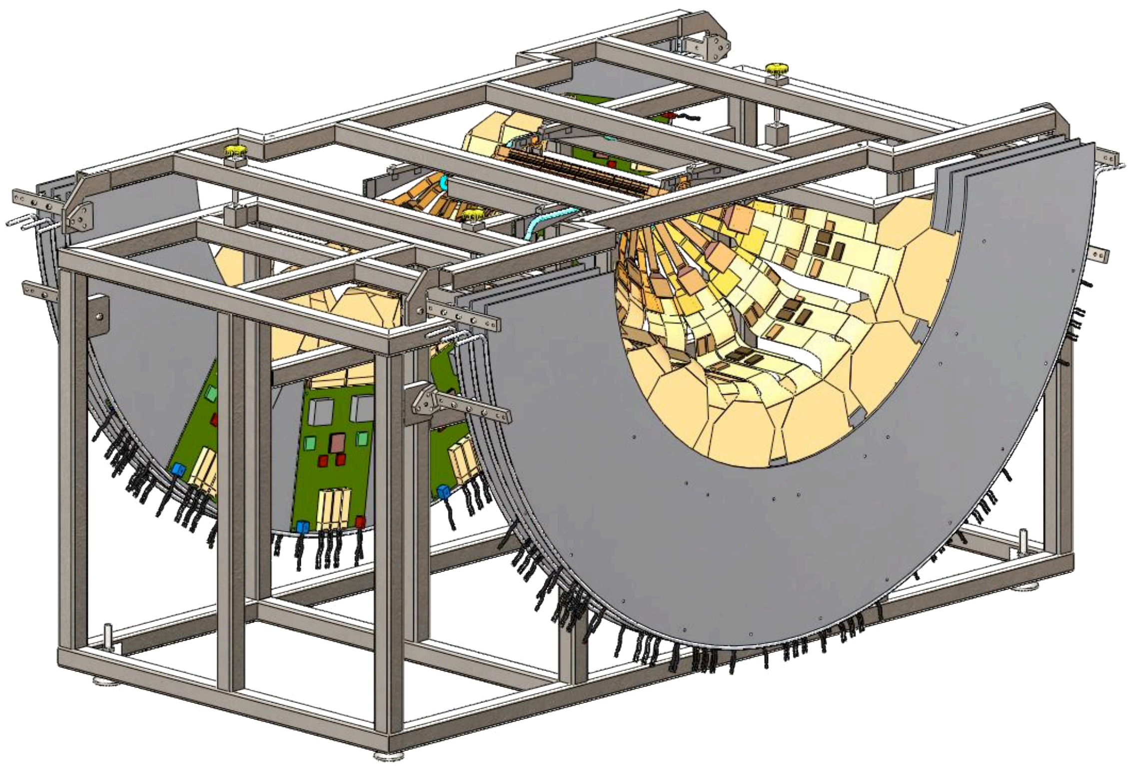
Main assembly, barrel 1 placed on barrel 2

- The barrel 1 assembly is taken in its transport stand to the layer 2 assembly fixture
- This fixture will serve as the transport fixture for both layer 1 and 2 into the BNL assembly support structure



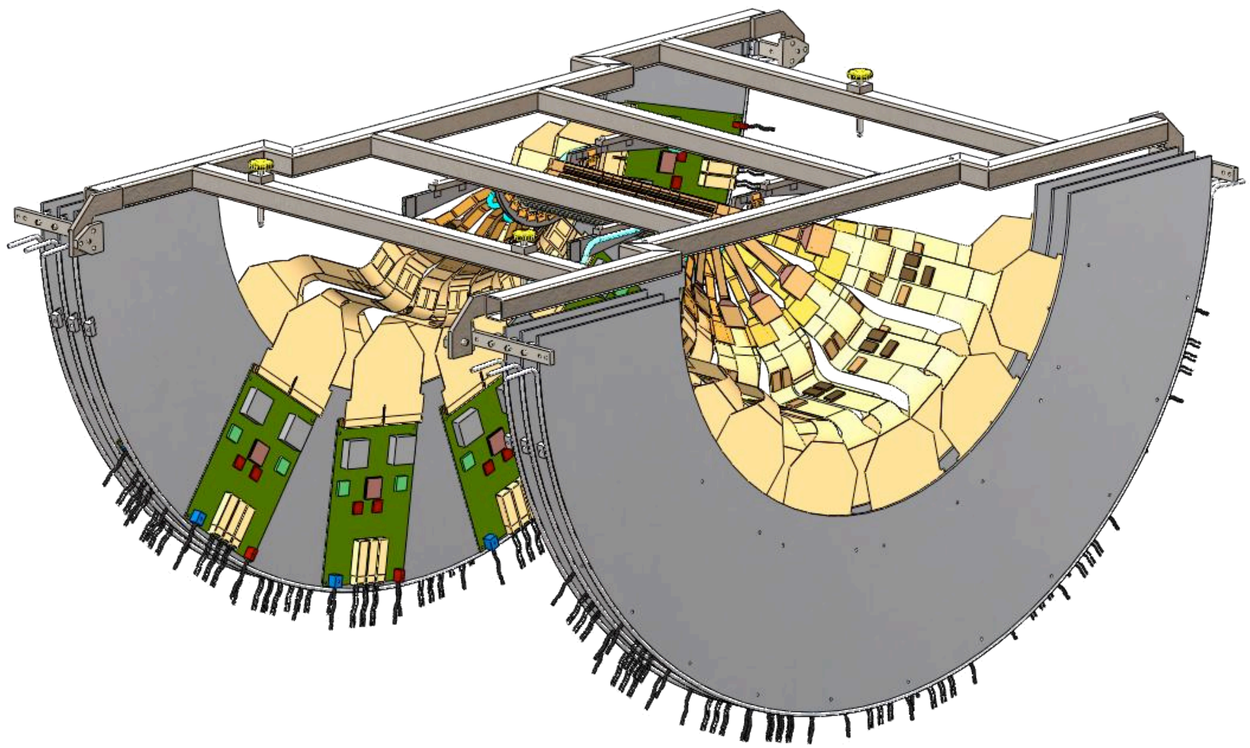
Barrel 1 mated to barrel 2

- Barrel 1 Assembly is attached to the Barrel 2 Assembly
- Layer 2 barrel mount is reattached to the backside of the layer 1 barrel mounts using 2-56 screws and nuts (8)
- Barrel 2 Big Wheels are transferred from the Barrel 2 Assembly Fixture to the Barrel 1 & 2 Transport Frame



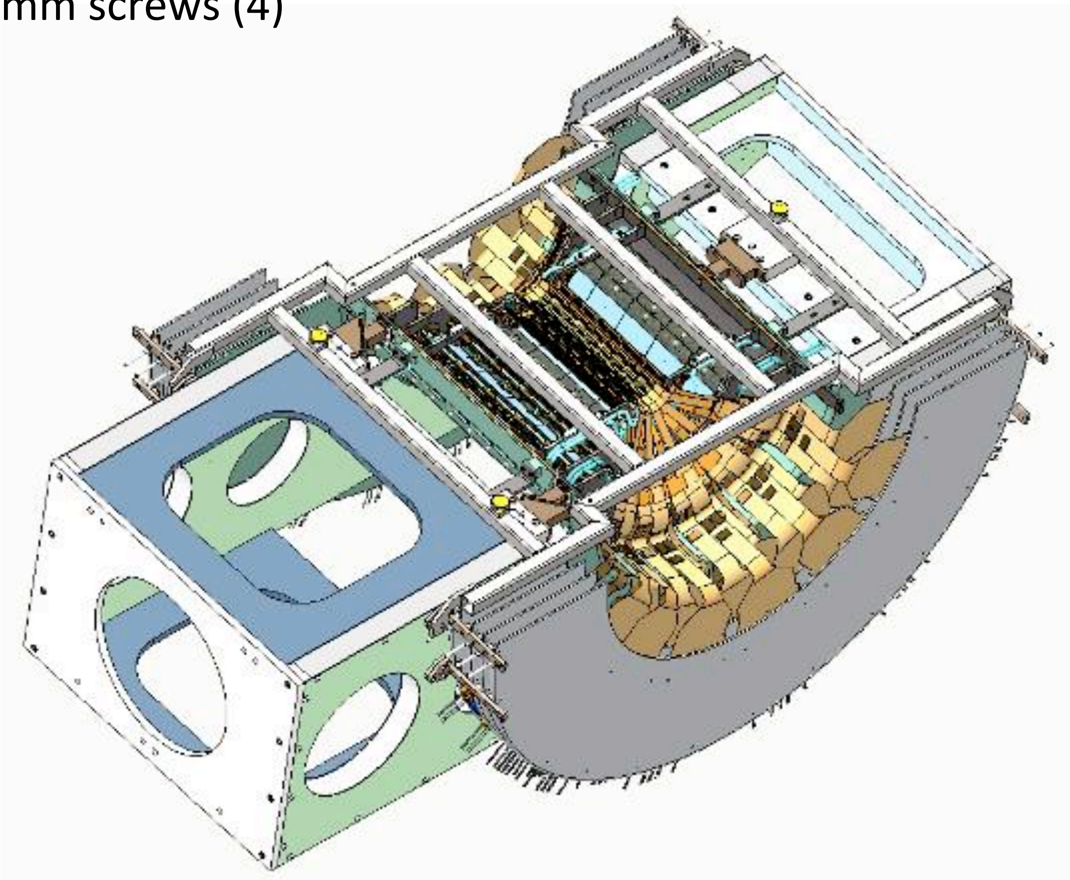
Barrels 1 and 2 transported

- Barrel 1 & 2 Transportation Frame is used to move the Barrel 1 & 2 Assembly from the Barrel 2 Assembly Fixture to the Main Assembly
- NOTE: This transfer includes all six Big Wheels associated with the Pixel layers 1 & 2, their X position is limited by the cable lengths



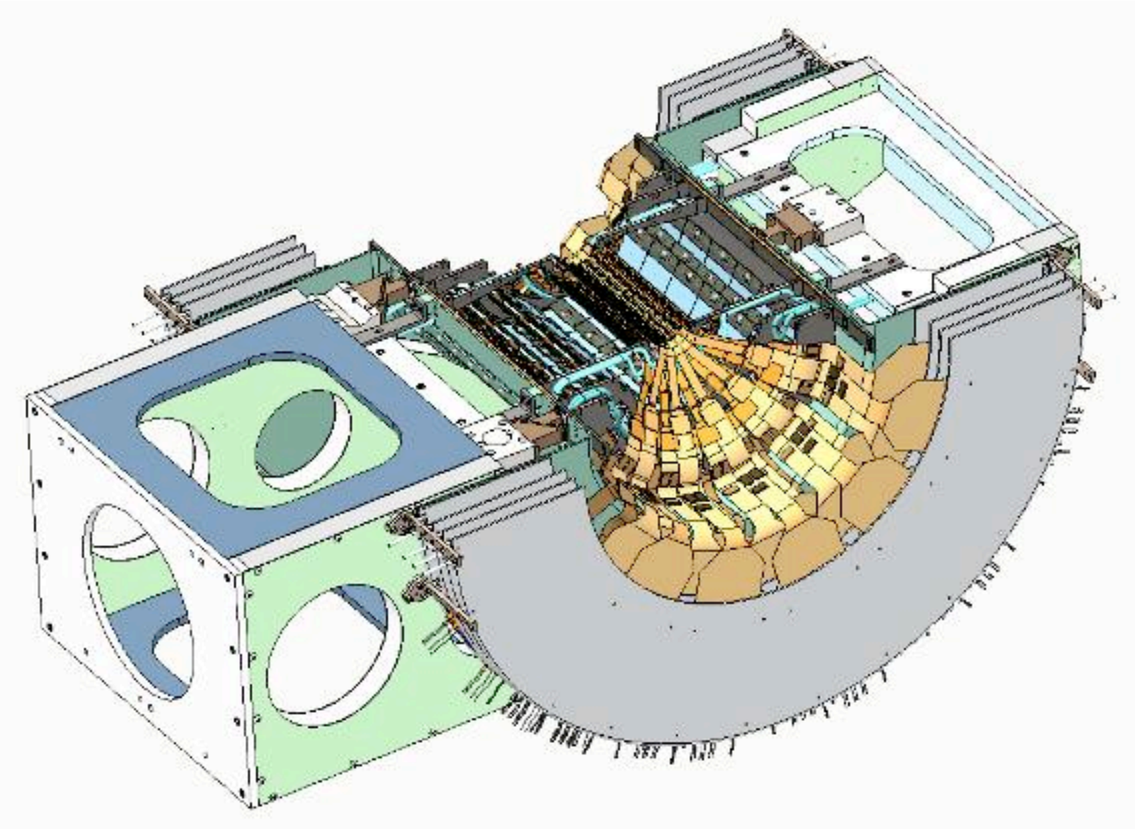
Main assembly, layers 1 and 2 added

- Barrels 1 and 2 placed in BNL support structure
- Verify position of Big-wheels in support structure
- Barrel mounts for layer 1 attach to main-beam using extractable pins (4) and M3x.5 X 12 mm screws (4)



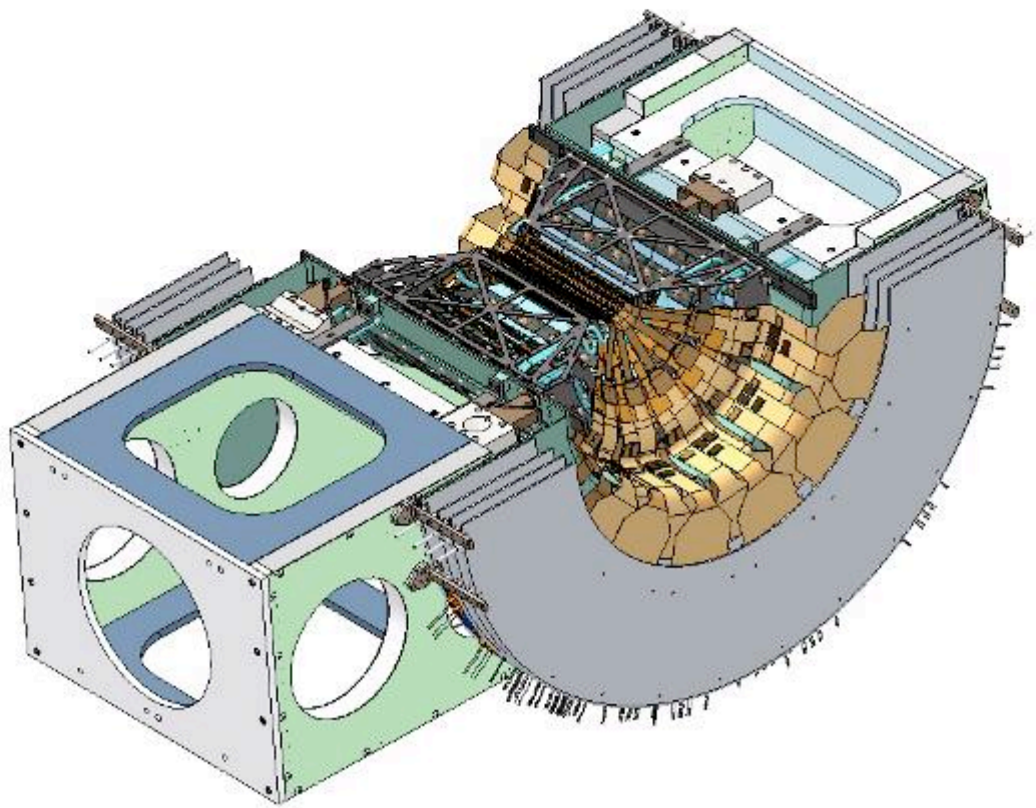
Barrels 1 and 2 transport frame removed

- Barrel 1 & 2 Transport Frame is removed from the BNL support structure
- Cooling Tube connections through the Gas Enclosure are made
- Upper Big-wheel support brackets (4) along with spacer are added to support structure



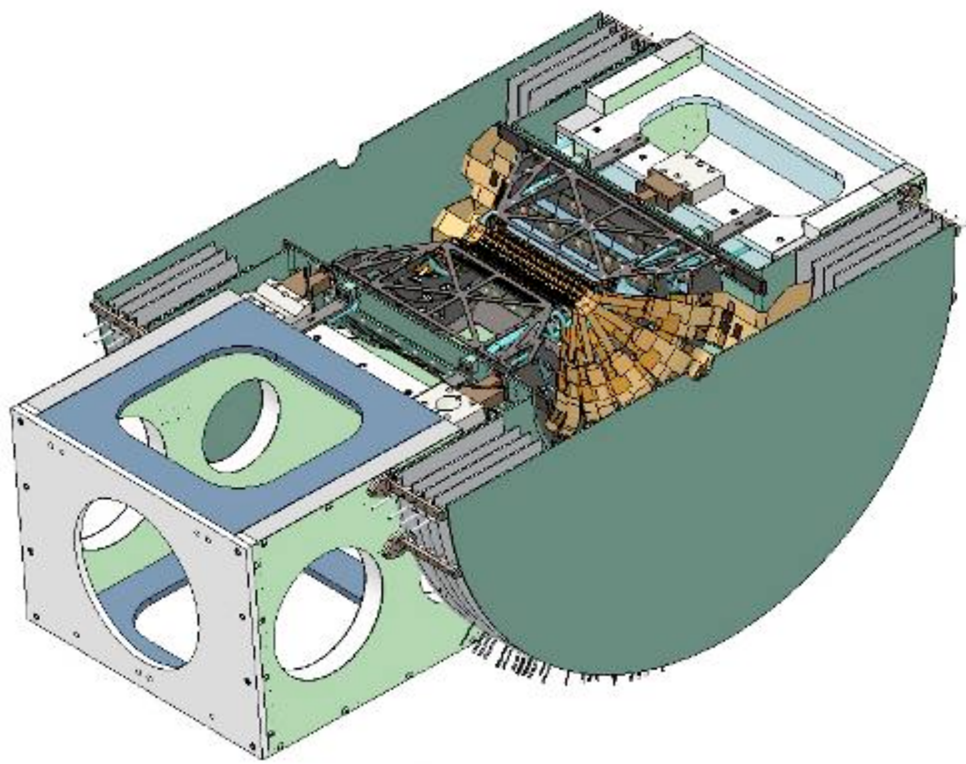
Add the mid-plane lateral stiffners

- Install 2 111-PHX-02-2019 VTX lateral stiffeners, attachment is made to the 1, 3 and 4 barrel mounts using 20 M3x.5 X 6.0 mm long screws



Gas enclosure end plates added

- The FR-4 gas enclosure end plates are added (location of FVTX readout plate)
- Silicone gas seal material as well as readout circuit board Gap-pad material added as required
- A taller gas seal needed layer 1 plated and end plate
- Use of U-clips around perimeter of Big-wheels may be necessary to make seal



Final assembly

- Install the dry Nitrogen gas lines and their mounting block

VTX Survey Plan

Don Lynch and Rich Ruggiero
8/5/2010

VTX Survey Plan Elements/Schedule

1. New beampipe alignment and survey. (Alignment End of August/early September).

2. VTX pre-survey detector interior reference points to exterior targets. (Mid to end of September)

   - Establishi internal and external references from known internal construction points
   - check the positioning of a representative sample of chips to their nominal design positions.

3. VTX pre-survey of East and West ½ detectors to each other and alignment rails. (End of September).

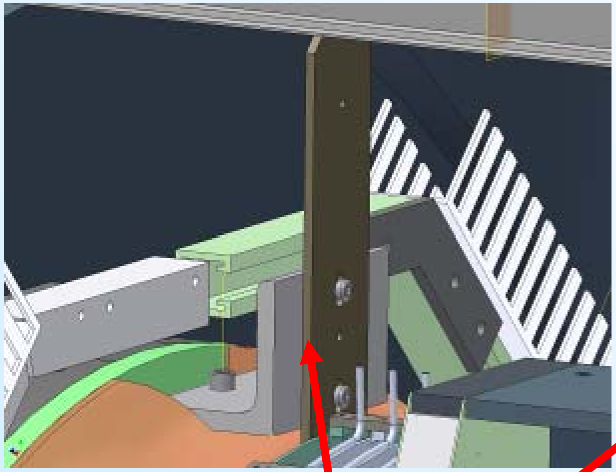
   - Pre-survey the East and West ½ detectors on a simulated IR installation so as to establish a baseline to be reproduced in the IR.
   - Actual points to be used will be established by survey team when they set up for this step.

4. VTX final survey and alignment in PHENIX IR. (Mid to end of October). We descri

   - Want to reference targets at the 3 mounting feet for the West ½
   - Accept the inherent accuracy of the kinematic mounts to locate the east.

Each step of these tasks is time consuming.The surveyors are already heavily loaded with work during this shutdown, so it is critical that we communicate where we are in our project at any time so that Frank can schedule these tasks in a timely and efficient manner.

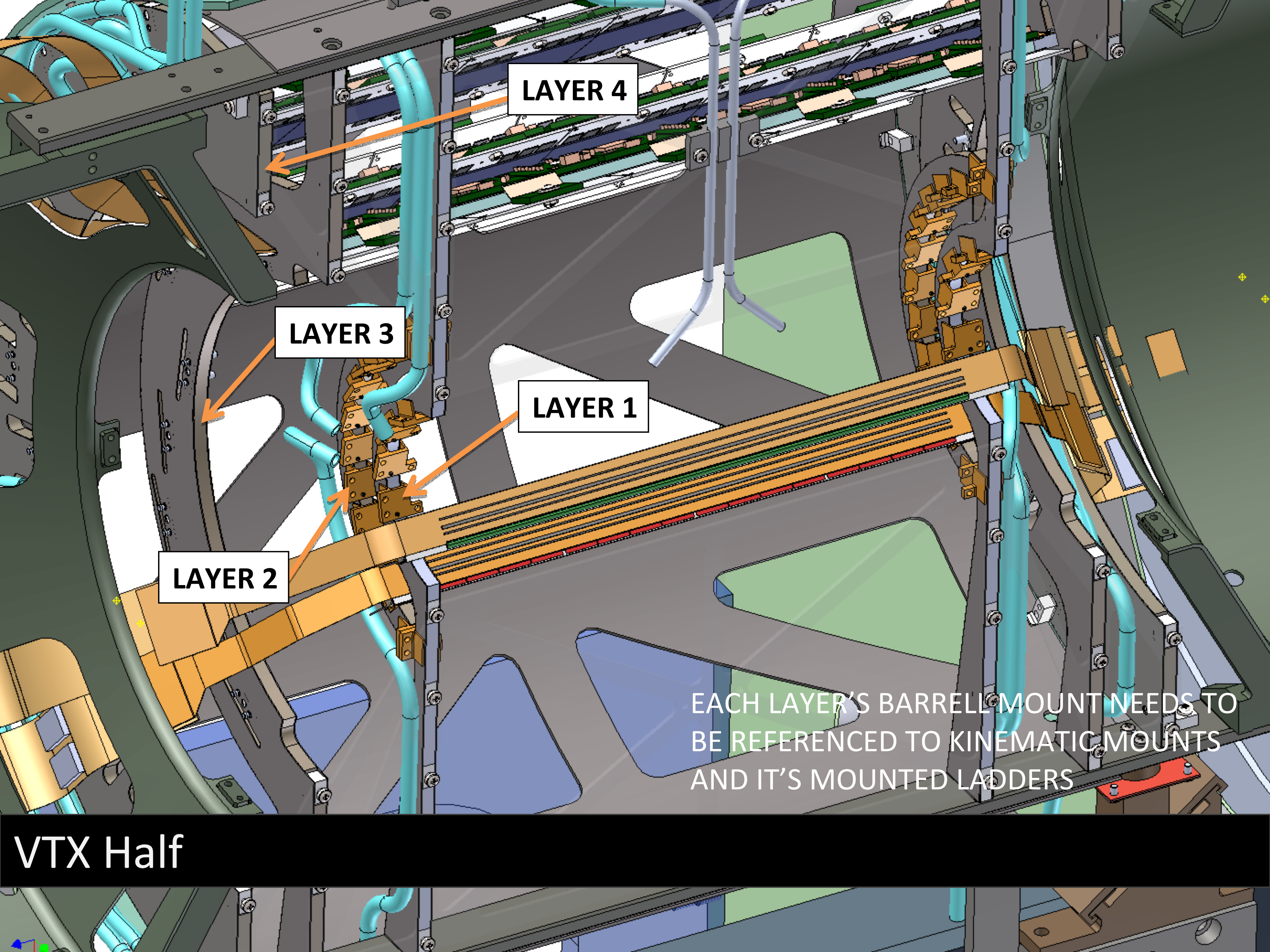
Survey of VTX and survey of Beampipe are currently in design. VTX to be presurveyed at assembly on rails and related to a few key targets (to be determined with Frank Karl).



Beampipe Survey Targets and fixtures must be able to align BP to req'd radial and angular accuracy without VTX and with VTX in clamshells open configuration.

2 target holders are positioned on beampipe at north and south end of detector. 2 targets are mounted on each holder to establish radial line from beampipe.

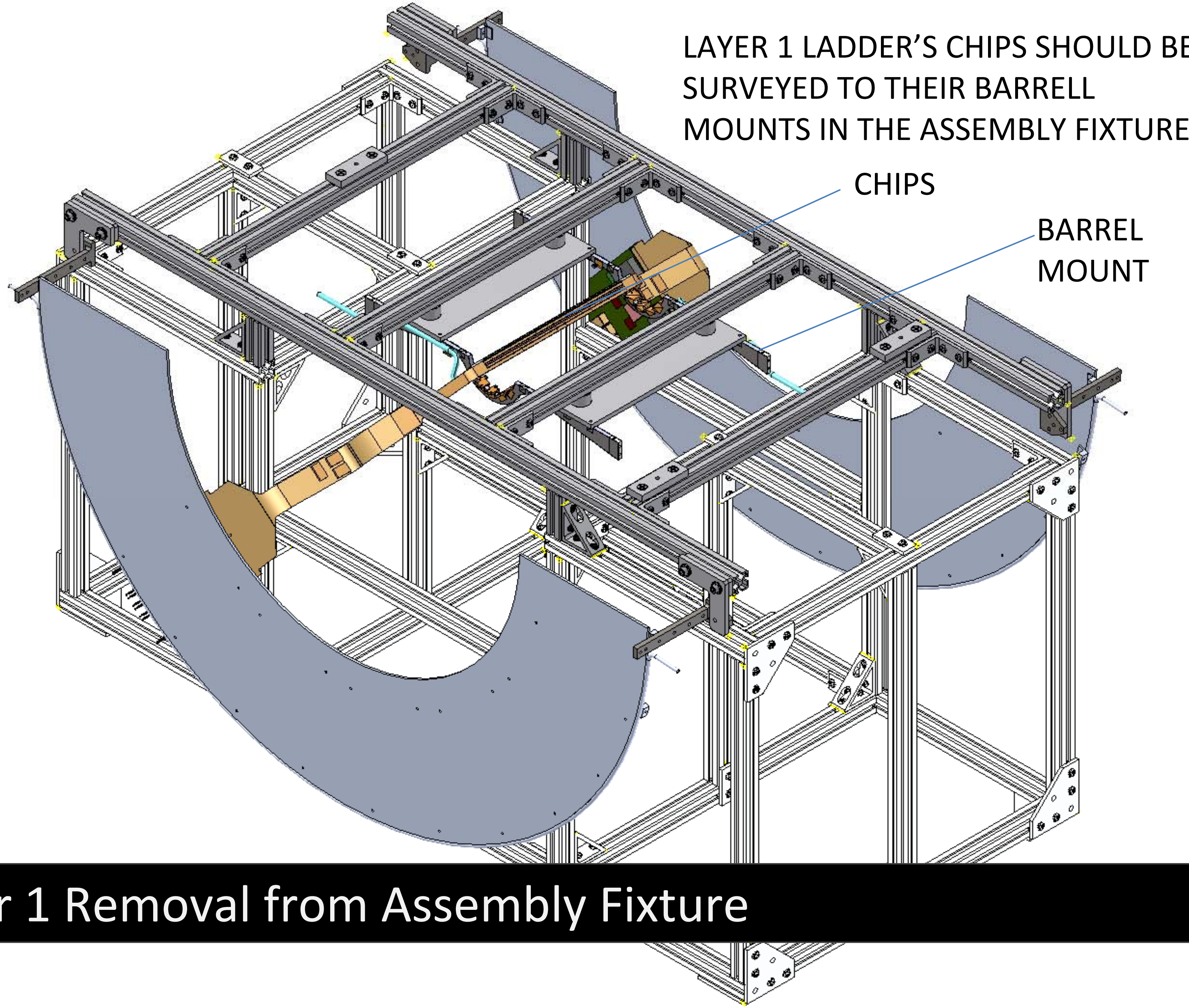
4 total targets allow axis of beampipe to be aligned with nominal beam orbit.


LAYER 4
LAYER 3
LAYER 1
LAYER 2
EACH LAYER'S BARRELL MOUNT NEEDS TO BE REFERENCED TO KINEMATIC MOUNTS AND IT'S MOUNTED LADDERS

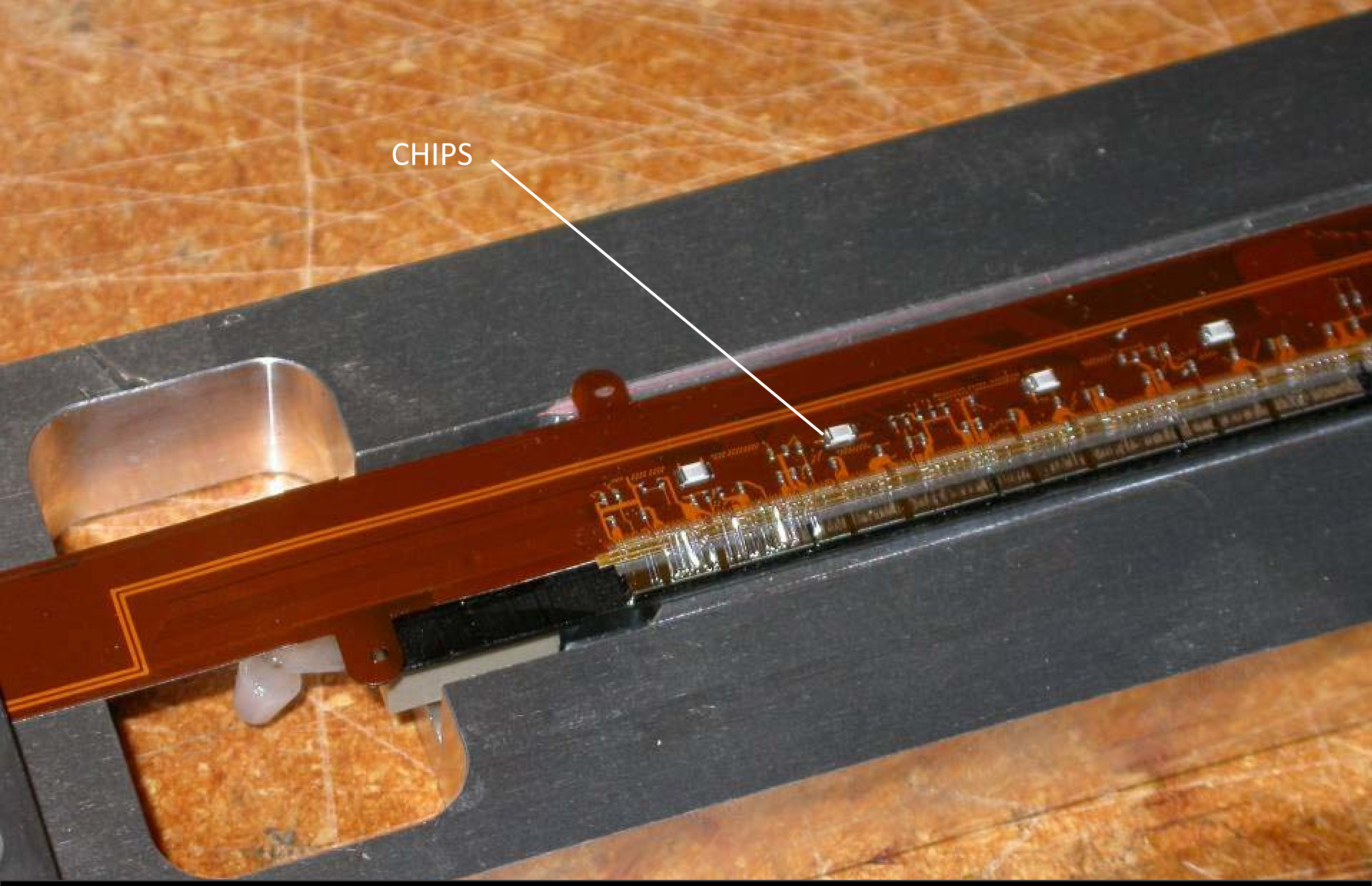
VTX Half

BARREL SECTION FACE SKIN INSTALLED

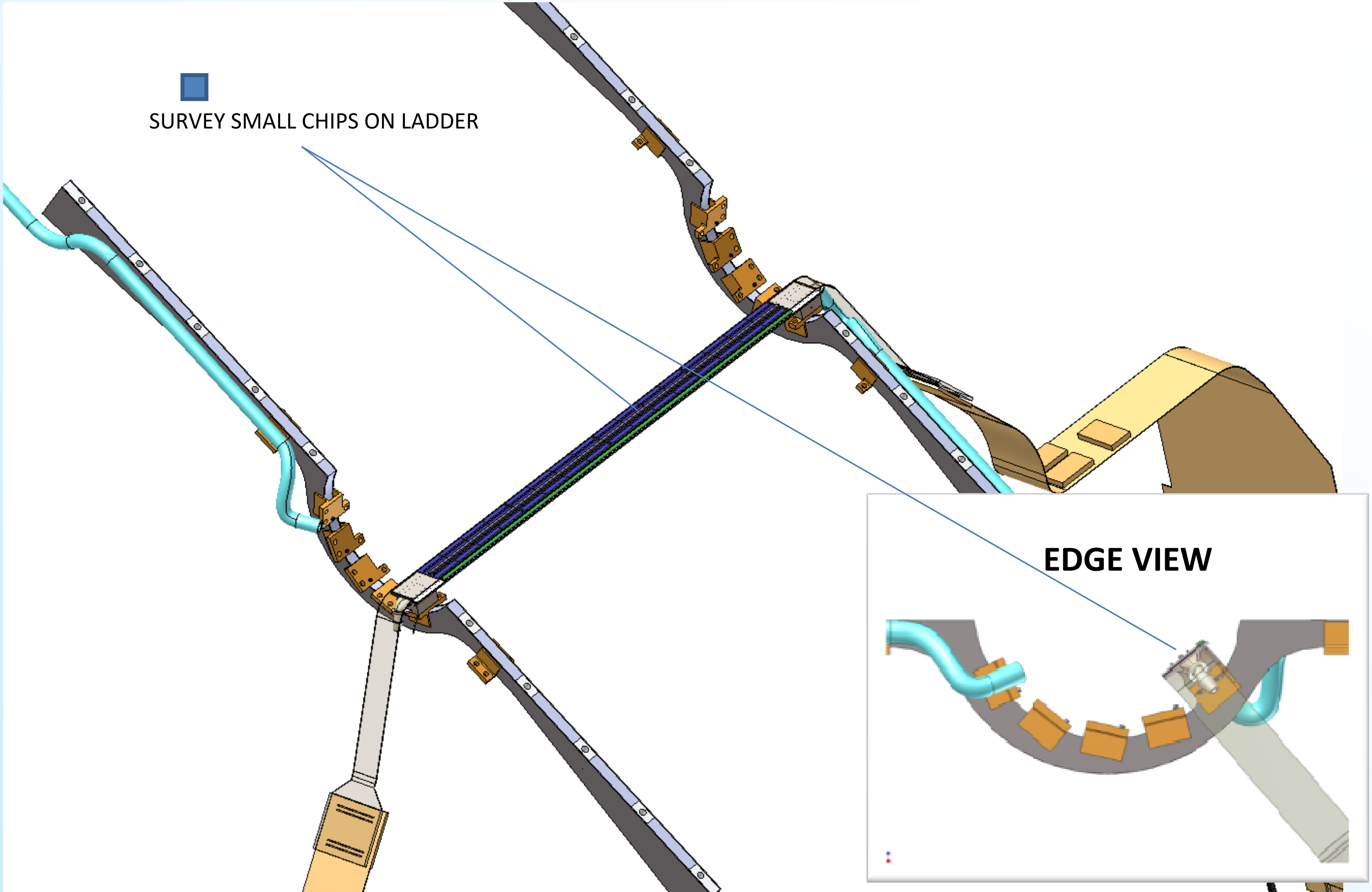
Layer 1 Removal from Assembly Fixture



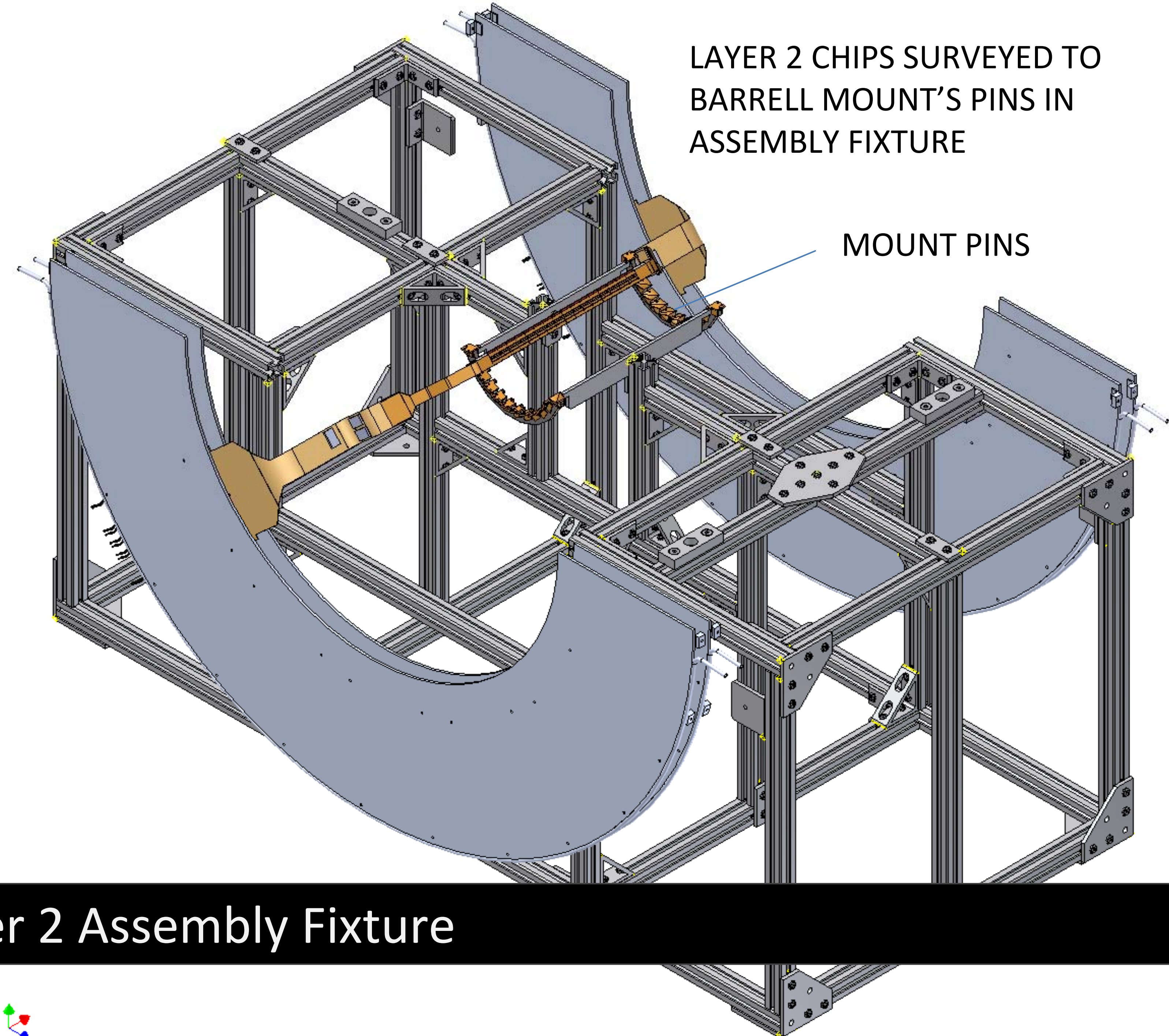
Pixel Ladder Assembly



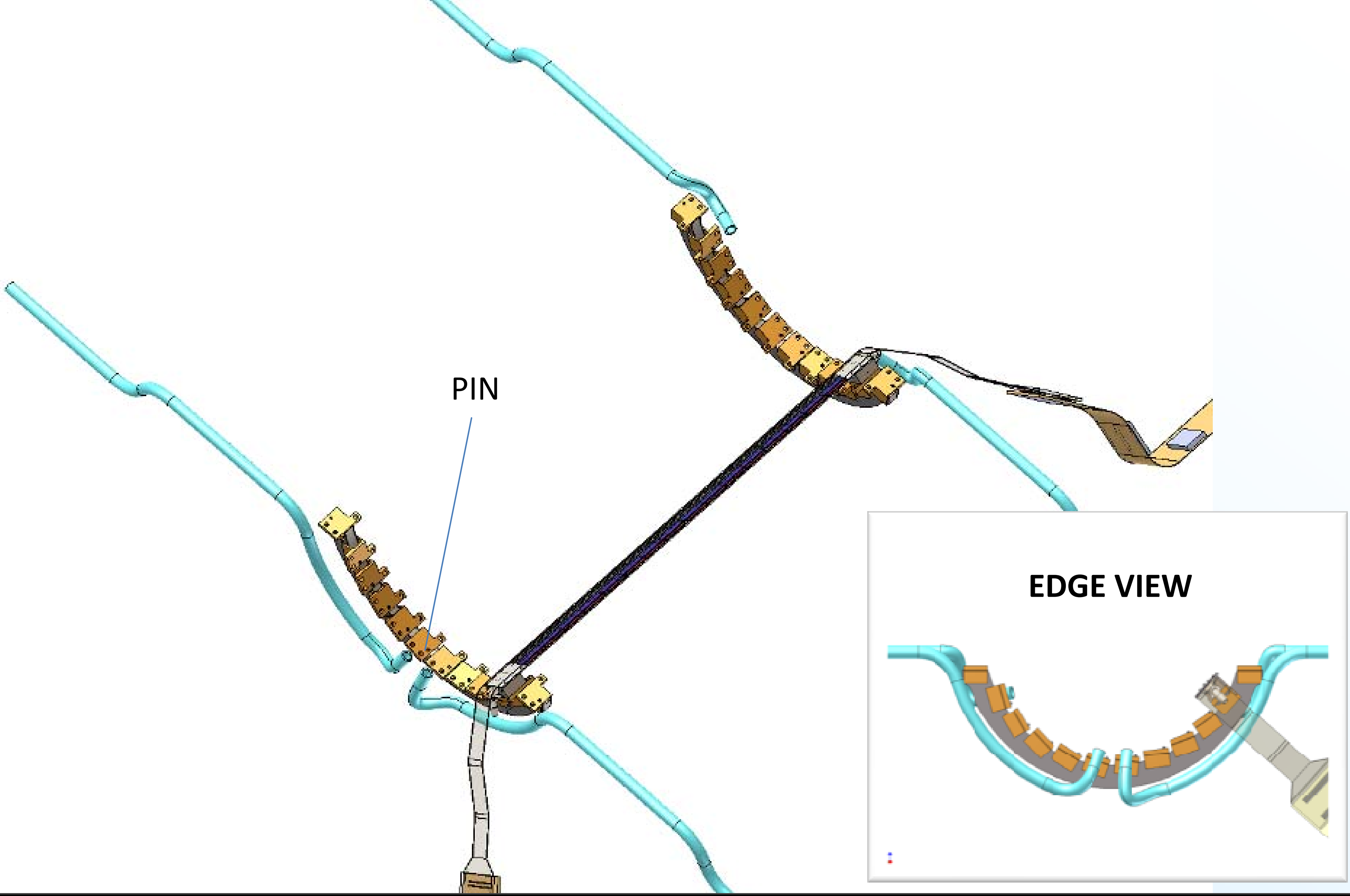
Pixel Ladder Assembly Close-up



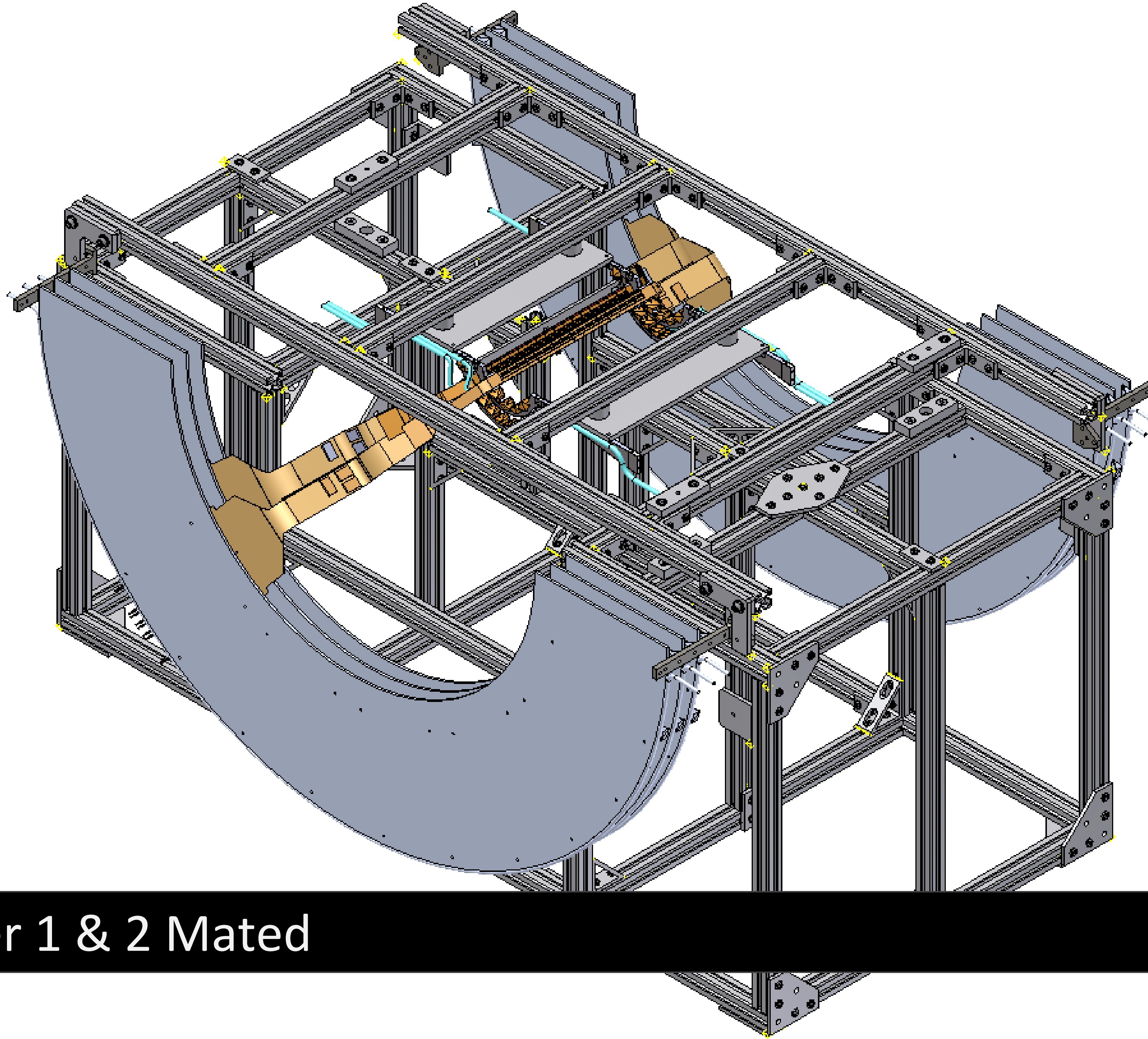
Layer 1



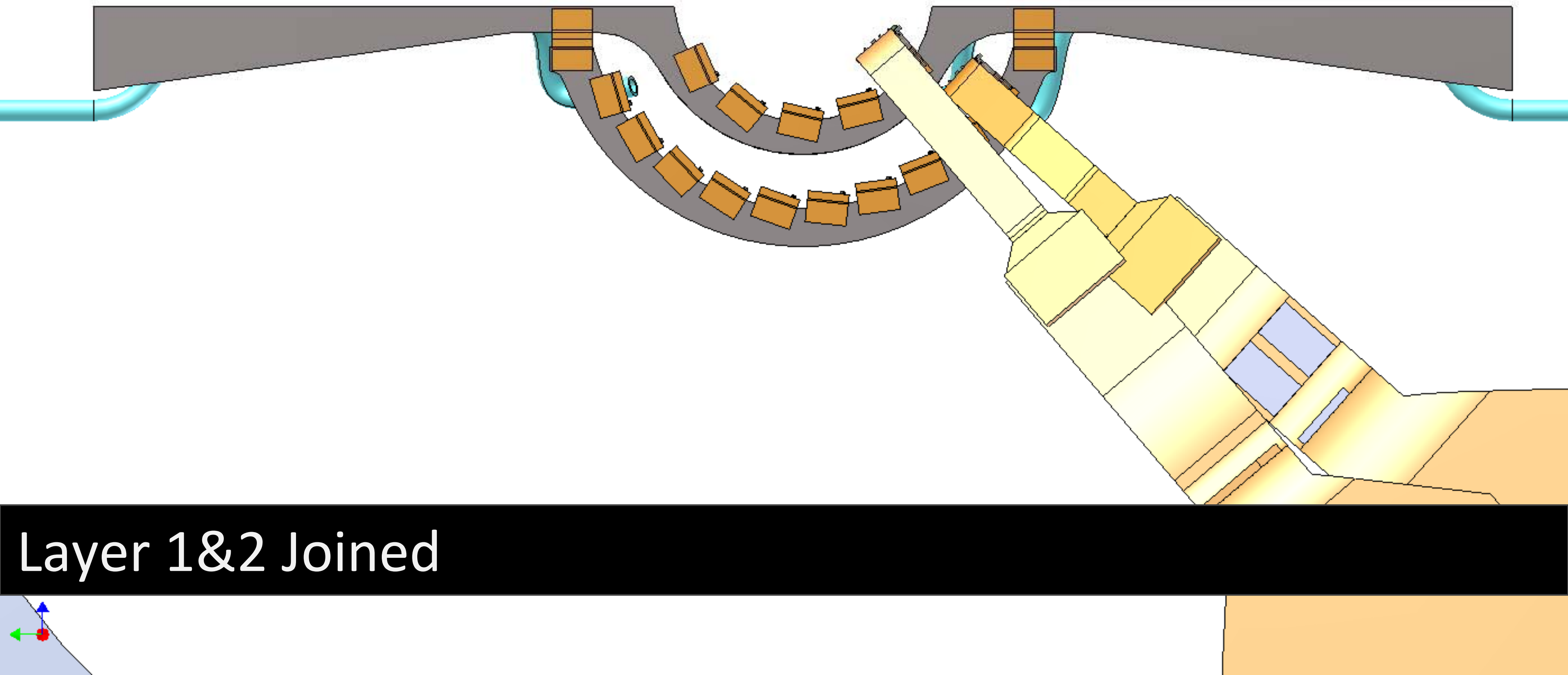
Layer 2 Assembly Fixture



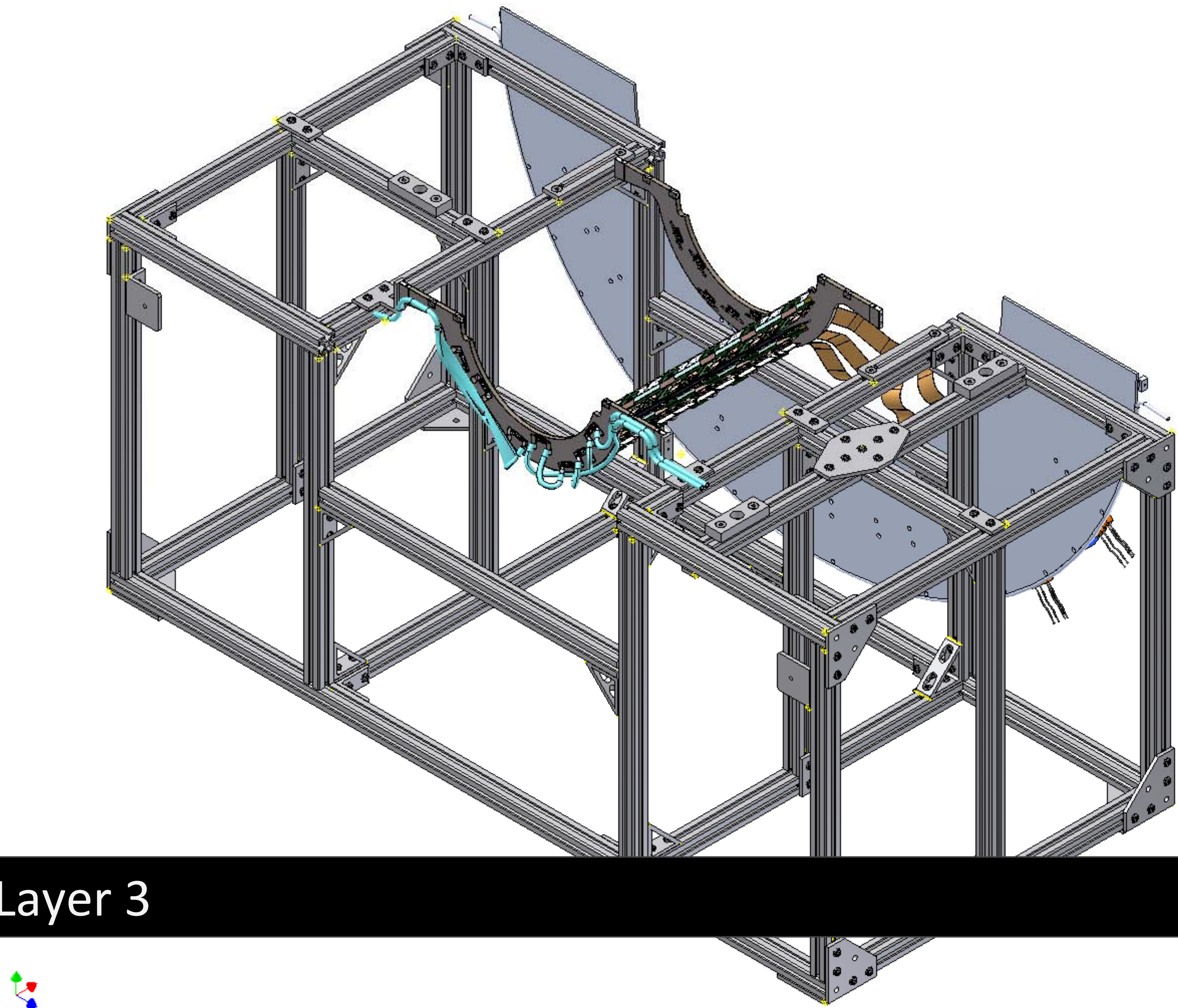
Layer 2



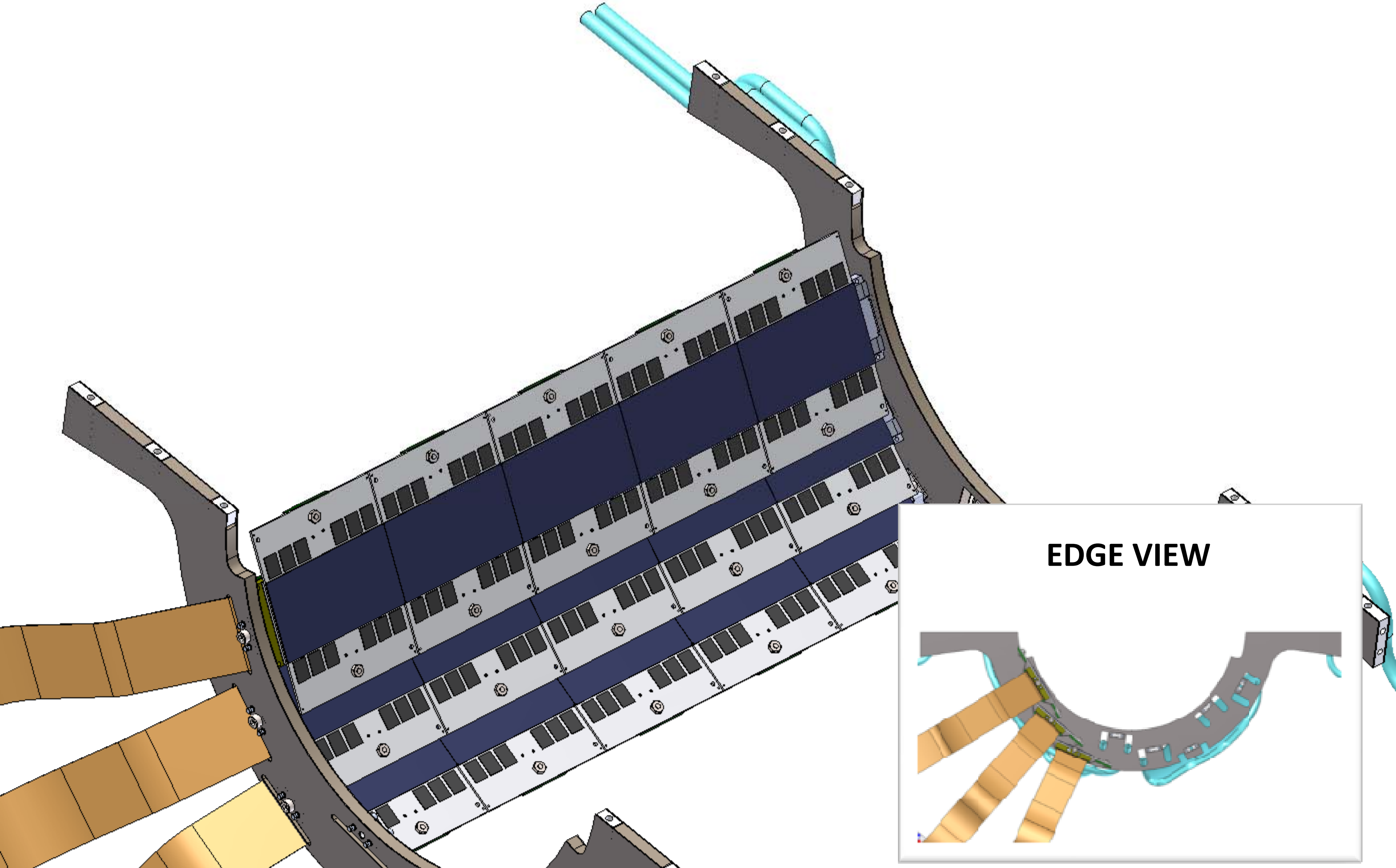
Layer 1 & 2 Mated



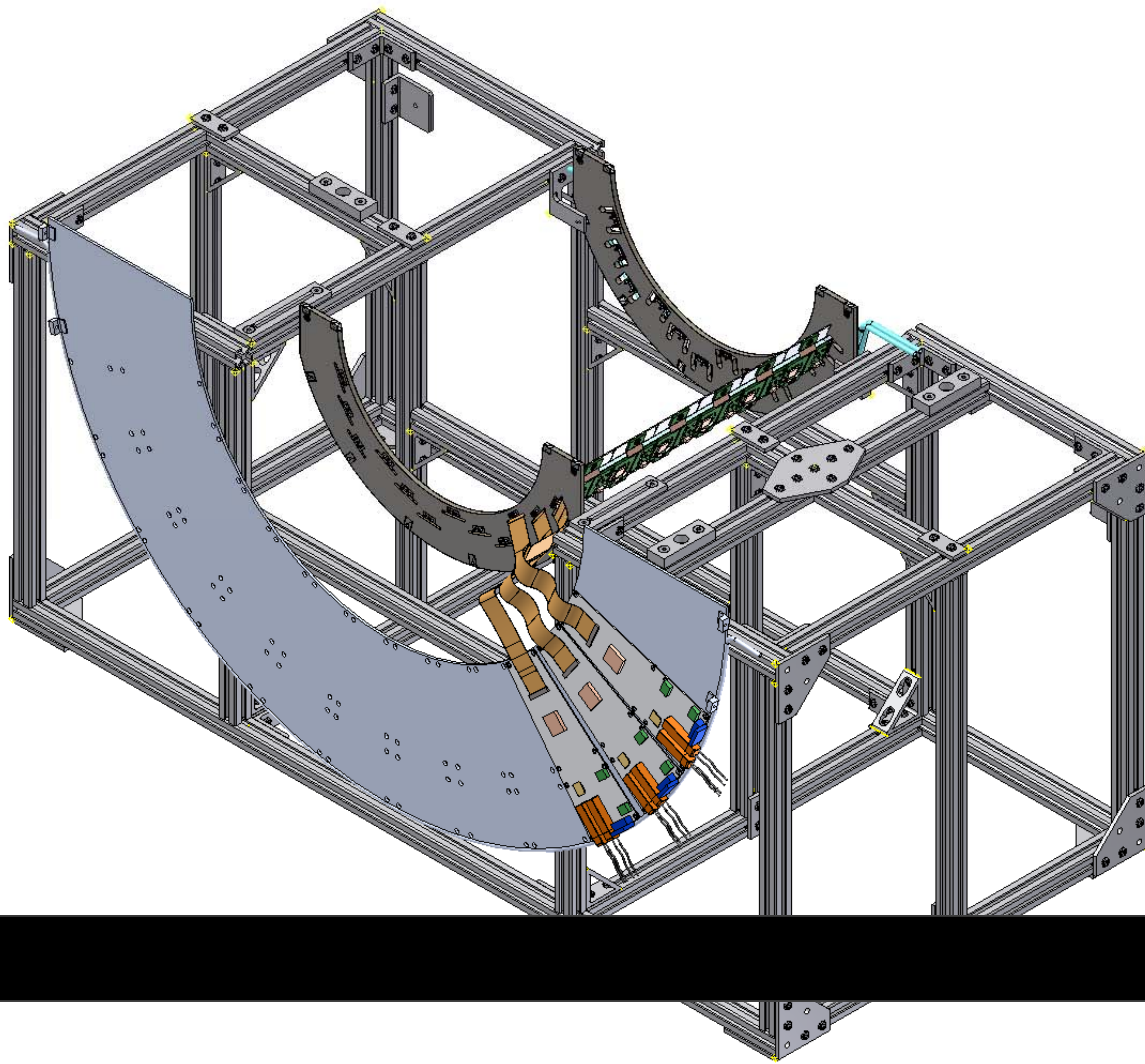
Layer 1&2 Joined



Layer 3

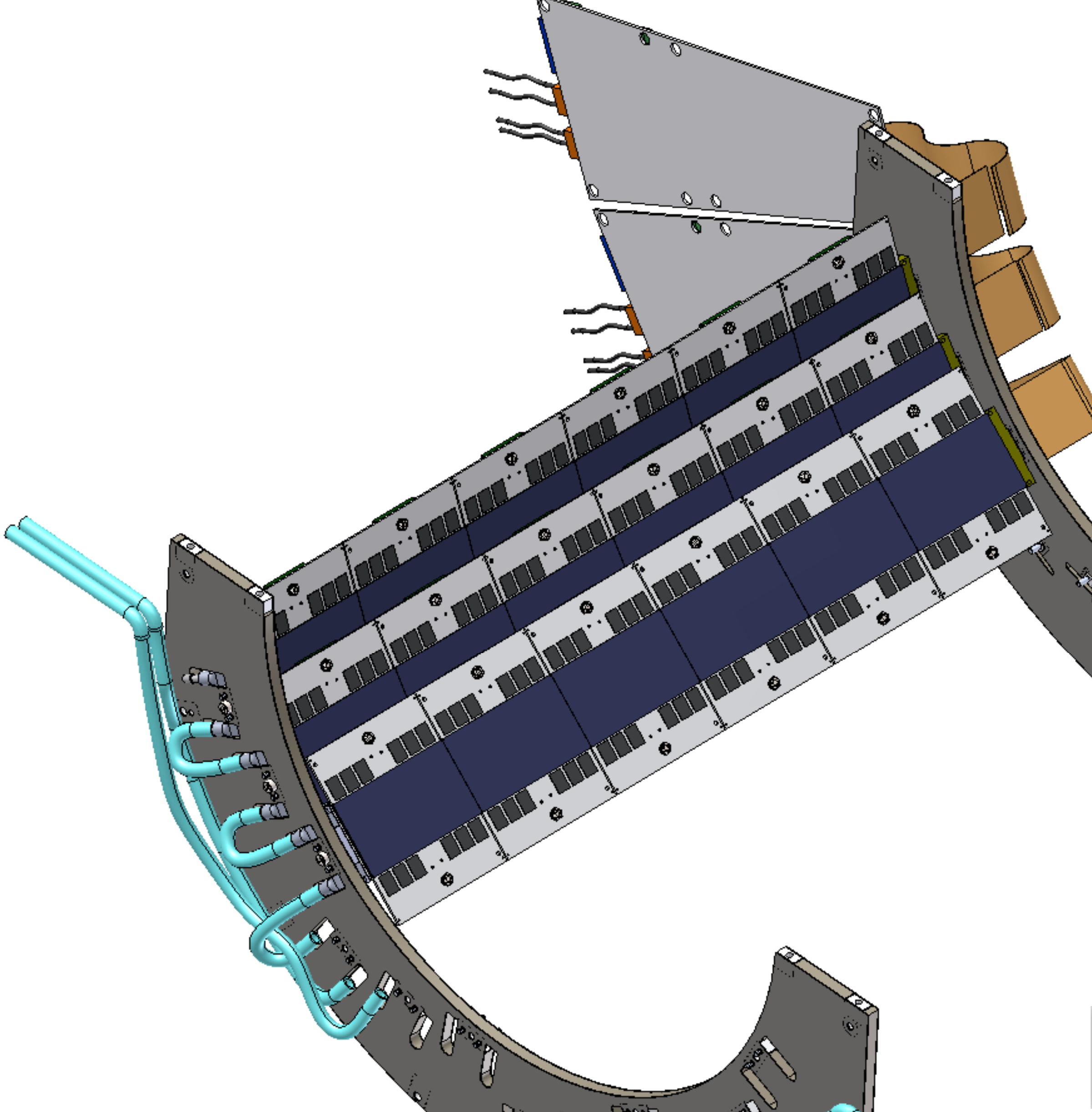


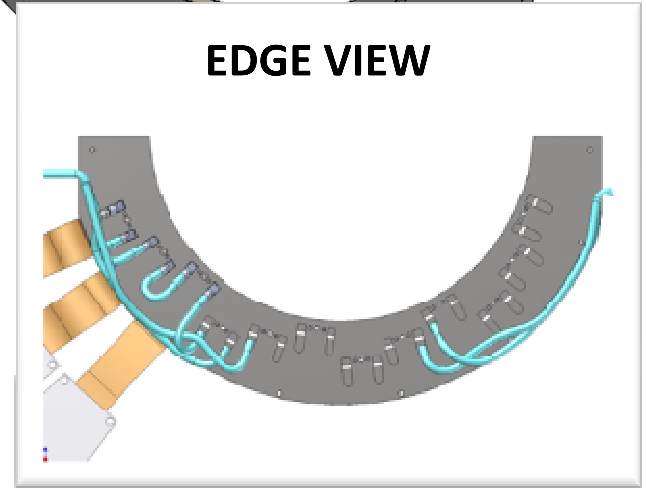
Layer 3

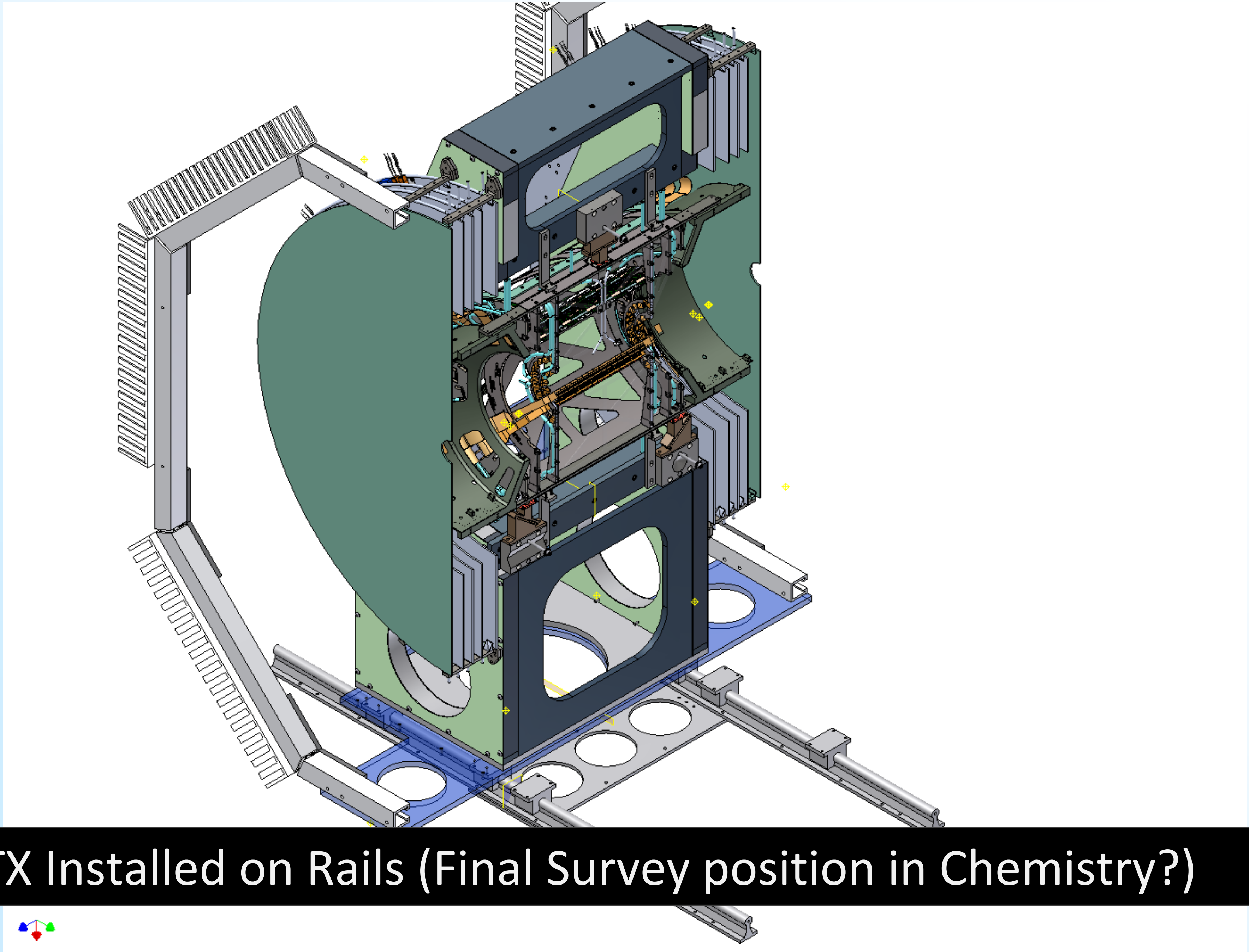


Layer 4

Layer 4







VTX Installed on Rails (Final Survey position in Chemistry?)

VTX Installation Procedure

Introduction

During the 2010 shutdown the PHENIX technical staff will be installing a new silicon vertex tracking detector subsystem designed to provide greater precision and scope to the PHENIX experiment. This system, abbreviated as "VTX", will be installed in the PHENIX Central Magnet ("CM") between the CM poles and around a new PHENIX beampipe. This space within the PHENIX complex was most recently occupied by the PHENIX HBD and RXNP detector subsystems which were retired in the spring of 2010 after each had completed a successful term of service to the PHENIX experiment. The VTX plans to build upon the service of these detectors as the PHENIX experiment probes deeper into the nature of sub-atomic particles.

The VTX is comprised of 4 concentric layers of detectors with the inner most 2 layers of the pixel type detector and the outer 2 layers of the strip-pixel variety. The detector signals are read out to circuit boards which amplify and convert the signals to light signals to be transferred to the PHENIX Data Acquisition system via optical fibers. These support electronics are mounted on large circular aluminum disks dubbed "big wheels". The detector and support electronics on the big wheels are cooled to predetermined temperatures for optimum operating conditions using a proprietary thermal transfer fluid, NOVEC 7200. The internal atmosphere of the detector subsystem is kept free of condensation/moisture by flowing gaseous nitrogen.

Three separate chillers have been procured, one for the internal detector electronics, another for the "big wheel" electronics and the third as a spare. These chillers require water cooling of their condensers and 3 phase 480V power. Cables, cable management/support structure, and power supply/distribution and breaker panels will be required as will piping, fluid distribution and support structure and manifolds for both the coolant and the water cooling are required.

There will also be 2 electronics racks required to support the VTX. One rack will be mounted on the CM "bridge" platform (above the CM upper flux return) and the other on the east side of the CM adjacent to the CM lower flux return. The upper rack will supply HV and LV to the detector electronics while the lower rack will house the fiber optics patch panel for the detector signal processing. Each of these require cables, cable management and support hardware, etc.

In this document, all facets of the preparation, assembly, installation, alignment, and commissioning of the detector itself and its support equipment are discussed, related documents are referenced and the procedures to be followed are detailed.

Assembly, Pre-Survey and Pre-Alignment

The VTX assembly is currently in progress at various PHENIX laboratories and work spaces in the PHYSICS and Chemistry departments at BNL. Detector electronics and internal signal processing electronics, structural and assembly components and assembly fixtures have been designed by the VTX detector group and PHENIX engineering with appropriate controlled documentation. These items have been fabricated at external PHENIX collaboration locations around the world, under subcontract by various highly skilled subcontractors, at PHENIX local facilities and at the BNL central shops. The procedures for assembling the VTX detector into its 2 halves (east and west) to prepare the detector halves for installation into the PHENIX CM are described and illustrated in the attached **VTX Assembly Plan.**

During this procedure at appropriate levels of partial assembly, PHENIX technicians and BNL surveyors shall make a series of inspection measurements. These measurements are performed to assure positioning and alignment of internal components to the drawing requirements for accuracy and tolerance and to establish reference points to relate inner layers of the detector to outer layers and ultimately to the external surfaces of the completed detector. Since each layer tends to obscure the layer before it during assembly, it is critical that these reference points are established at appropriate junctures during the assembly.

The pre-alignment and pre-survey details are described and illustrated in the attached **VTX Survey Plan.**

Site Preparation

During the 2010 shutdown and prior to commencing the installation of the VTX detector 1/2's into the CM region, four major related tasks need to be addressed:

(1) Remove and retire the HBD detector subsystem, which occupied part of the CM region where the VTX is intended to be installed. This is fully described in a separate PHENIX Work Permit, DRL-2010-9

(2) Remove and retire the RXNP detector subsystem, which also occupied part of the CM region where the VTX is intended to be installed. This is fully described in a separate PHENIX Work Permit, DRL-2010-10.

(3) Remove all sections of the existing beampipe between the south and north PHENIX vacuum isolation valves and replace with new sections of beampipe, reusing the 2 bellows, which incorporate new features including internal Non Evaporable Getter (NEG) coating and a smaller diameter central beryllium section. This is fully described in a separate PHENIX Work Permit, DRL-2010-14.

(4) Install new east-west rails to provide structural support and alignment capabilities, as well as the ability to separate the two halves of the VTX detector for maintenance, repair, troubleshooting and upgrades as well as to allow the PHENIX CM to be translated along the PHENIX beamline to allow work to be performed on other PHENIX subsystems during maintenance shutdown periods. This installation effort is worker planned work and is fully described in the PHENIX VTX controlled installation drawing. The installation and alignment of the VTX itself on these rails is described in the next section of this procedure.

Note: there are other related activities to be performed during the 2010 shutdown, which have an incidental effect on the schedule and/or installation procedure, but are not strictly related to the VTX installation. These efforts are described in their own work permit documents and not reproduced here.

Installation Procedure

(Please refer to the attached VTX Installation Plan for illustration of the installation plan concepts described below)

I. West Detector section

a. After completion of assembly, pre-survey and alignment of the 2 VTX detector halves, the west half shall be mounted on the VTX Installation fixture with the OD of the detector facing down and transported to the PHENIX Assembly Hall ("AH"), taking care not to jostle or otherwise disturb, distort, twist or shock the assembly.

b. Install the east and west support rail installation extensions. Install the soft beampipe shield and hard beampipe protectors around the central beampipe.

c. Rig the west VTX detector half onto the PHENIX 12 ton cart in the AH then roll the cart into the IR.

d. Rig the west VTX detector half from the 12 ton cart to the east extension rail with the top of the detector facing west and the OD of the detector half facing down.

e. Slide the west VTX detector half carefully under the Beampipe taking care to avoid any potential snags or pinch points, and taking exceptional care to avoid contact with the beampipe and/or the beampipe protectors (soft and hard)

f. After the detector is fully translated west under and clear of the beampipe, install stops to prevent the west half from contacting the beampipe.

g. Remove the hard and soft beampipe protectors.

h. Attach the IR crane to the lifting point on the VTX installation fixture and carefully rotate the beampipe into its upright and open position.

i. Check alignment and make sure the west half has been restored to its aligned position relative to the rails.

j. Align/Survey the west VTX detector half relative to the beampipe and PHENIX IR nominal IP, make appropriate corrections to the west half detector stops.

k. Retract west VTX to its "open" parked position.

II. East Detector section

a. Mount the east VTX detector half on the VTX installation fixture and transport the assembly to the PHENIX AH, taking care not to jostle or otherwise disturb, distort, twist or shock the assembly.

b. Rig the west VTX detector half onto the PHENIX 12 ton cart in the AH then roll the cart into the IR.

c. Rig the west VTX detector half from the 12 ton cart to the east extension rail in the upright position.

d. Slide the east half detector near the beampipe and make precision adjustments as necessary to get it near its final position.

e. Slide the west half detector into its aligned position against the rail stops.

f. Mate the east VTX detector half to the west half.

Final Survey and Alignment

After the VTX east and west detector halves have been joined survey the entire detector by the external reference points established during pre-survey and record all info in the PHENIX survey data base. (See the attached illustrated **VTX Survey Plan** for further information.)

Cooling, Gas Utilities and Electrical/Electronic Support

The VTX detector requires cooling of its internal detector electronics to approximately 0°C and its routing electronics ("Big Wheel" electronics) to approximately room temperature. VTX group experts have chosen Novec 7200 as the cooling medium for both internal and routing electronics, but these will be separate cooling loops supplied by identical water cooled chillers, which will be installed in the PHENIX AH near the plug door platform. Piping of the coolant shall be via insulated, stainless piping, routed through the sill to the CM where manifolds will distribute the coolant in accordance with the **VTX coolant flow plan**, attached. Water to supply cooling to the chiller condensers will be supplied by the PHENIX Electronics water supply. Installation of the chillers, cooling water for the chillers, piping for the cooling water and detector coolant and power supplied to the chillers are all to be performed in accordance with accepted BNL, CAD and PHENIX worker-planned-work common practices using common tools by PHENIX technicians, CAD technicians and BNL trades as appropriate. Planning for these tasks will be on a day-by-day basis as the tasks progresses. PHENIX engineering, CAD and/or BNL trades may identify specific tasks during this time as appropriate for enhanced work planning, and in such cases enhanced work permits for those tasks shall be generated by the person(s) designated as work control coordinator(s) for the specific workers performing those specific task(s). In such cases reference to such enhanced work planning shall be made on the work permit encompassing this procedure.

Gas utilities for this project consist only of gaseous N2, to be supplied by the PHENIX N2 gas system. Installation of the N2 flow control, piping, and all tasks in support of the N2 flow control and piping are to be performed in accordance with accepted PHENIX worker-planned-work common practices using common tools by PHENIX technicians. Planning for these tasks will be on a day-by-day basis as the tasks progresses. PHENIX engineering may identify specific tasks during this time as appropriate for enhanced work planning, and in such cases enhanced work permits for those tasks shall be generated by the PHENIX work control coordinator(s) for the specific workers performing those specific task(s). In such cases reference to such enhanced work planning shall be made on the work permit encompassing this procedure.

Electrical/electronic support shall consist of

- high voltage and low voltage cables routed from a single rack mounted on the bridge rack platform above the CM,
- fiber optic cables routed to a patch panel mounted in a rack mounted, in turn, on the east side of the CM (previously used as the HBD signal low voltage/signal rack)
- fiber optics trunk lines to the rack room
- appropriate rack room hardware and electronics
- appropriate cable management, cable tray and cable guide hardware
- appropriate power and software for the various racks and electronics within the racks

Cable management in the area local to the detector is illustrated in the attached **VTX Installation Plan.** The efforts to fabricate, assemble and install the electronics, cabling and associated support equipment are all to be performed in accordance with accepted BNL, CAD and PHENIX worker-planned-work common practices using common tools by PHENIX technicians, VTX system experts and BNL trades as appropriate. Planning for these tasks will be on a day-by-day basis as the tasks progress. PHENIX engineering, and/or BNL trades may identify specific tasks during this time as appropriate for enhanced work planning, and in such cases enhanced work permits for those tasks shall be generated by the person(s) designated as work control coordinator(s) for the specific workers performing those specific task(s). In such cases reference to such enhanced work planning shall be made on the work permit encompassing this procedure.

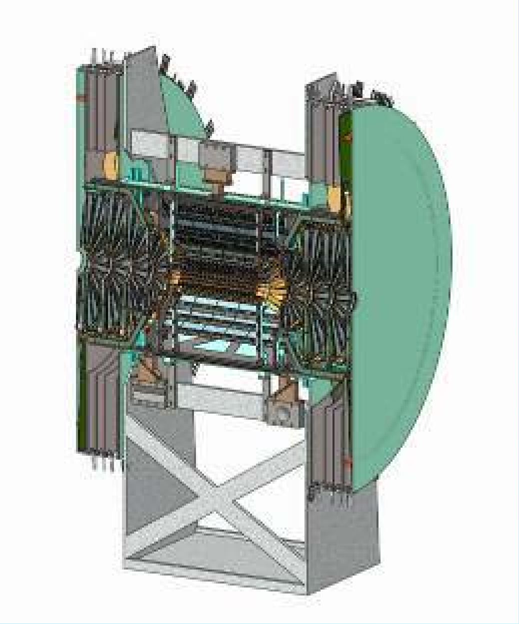
Testing and Commissioning

Testing and commissioning of the installed VTX detector subsystem shall commence immediately after mechanical installation of components is complete. This may be a partial or complete installation of the VTX subsystem as deemed appropriate by the VTX system experts in coordination with PHENIX DAQ system experts and work control coordinators. The testing and commissioning efforts shall be performed by PHENIX technicians, engineers and VTX subsystem experts. Planning for these tasks will be on a day-by-day basis as the tasks progress. PHENIX engineering may identify specific tasks during this time as appropriate for enhanced work planning, and in such cases enhanced work permits for those tasks shall be generated by the person(s) designated as work control coordinator(s) for the specific workers performing those specific task(s). In such cases reference to such enhanced work planning shall be made on the work permit encompassing this procedure.

Installation Closeout

When all work described in this work permit has been completed, the PHENIX work coordinator for this set of tasks shall collect feedback from all parties (PHENIX engineers and technicians and VTX experts). This feedback shall include critical review of any problems encountered during installation, solutions to such problems, changes to work procedures described herein during the conduct of this work, suggestions for improvements in equipment procedures and techniques and any other information deemed useful and/or relevant by the PHENIX work control coordinator. Such information shall be appropriately disseminated to the various affected/interested parties and a copy of this information shall be attached to this work permit when it is closed out.

VTX/FVTX Cooling Plan



4/6/2010

Don Lynch

PHENIX

In order to find an acceptable configuration and set of flow parameters a completely new set of flow and thermal calculations for the pixel staves, strip-pixel staves and FVTX disks 1-4 was set up.

The specifications fixed for the analyses were as follows:

Maximum inlet pressure: 20 psig
Maximum pixel sensor temperature: 20°C
Maximum strip-pixel sensor temperature: 0°C
Maximum FVTX disk sensor temperature: 20°C
Maximum pressure drop between external inlet manifold and external outlet manifold: 10 psid
Electronics heatloads

Additional input for the calculations: estimate ambient heat gain for detector is distributed among all cooling loops as a ~ 35% increase in sensor heat load. (Based on conservative ambient heat gain analysis.)

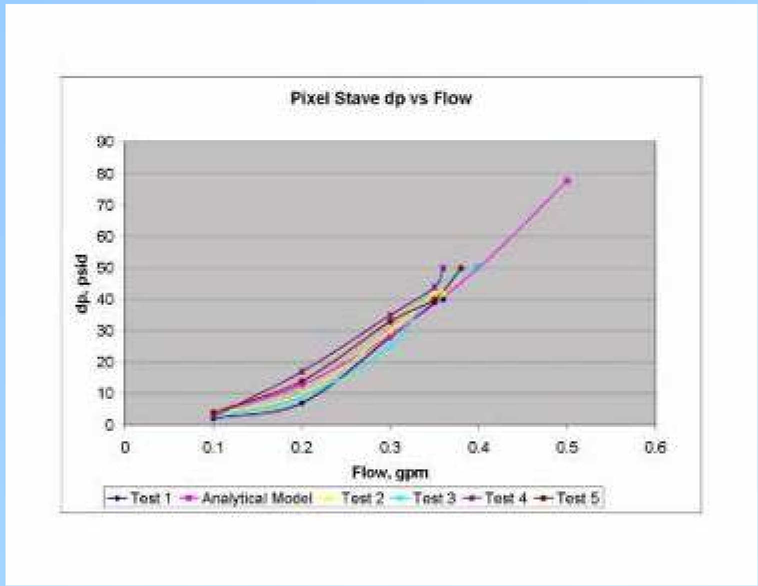
Temperature rise from cooling circuit wall temperature to sensor is derived from HYTEC thermal analyses: scaled from FEA calculation specified heat loads to tabulated (spreadsheet heatloads) and scaled again for 35% ambient load allowance described above. It is assumed that the FEA analyses

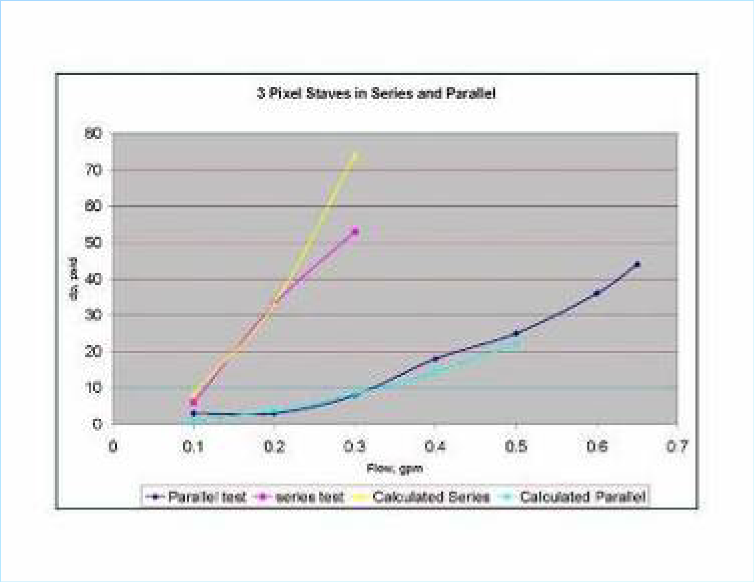
Flow calculations for FVTX based on available information in FEA, tabulating spreadsheet and flow diagrams provided by HYTEC. Calculations should be considered as design requirements for future FVTX design work to assure appropriate flow balancing.

Flow calculations were iterated until flows were balanced by pressure drop among all parallel loops and maximum exit temperatures for all loops met above requirements

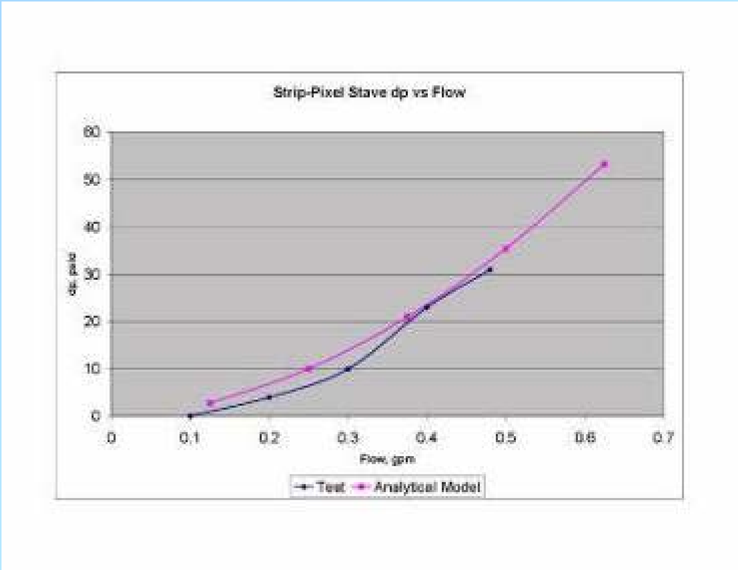
The FVTX exit flow will be channeled through an external heat exchanger to precool N2 flow to the detector gas enclosures. This will be established empirically during VTX installation and the results provided to FVTX for final thermal/flow design refinements after VTX installation this summer.

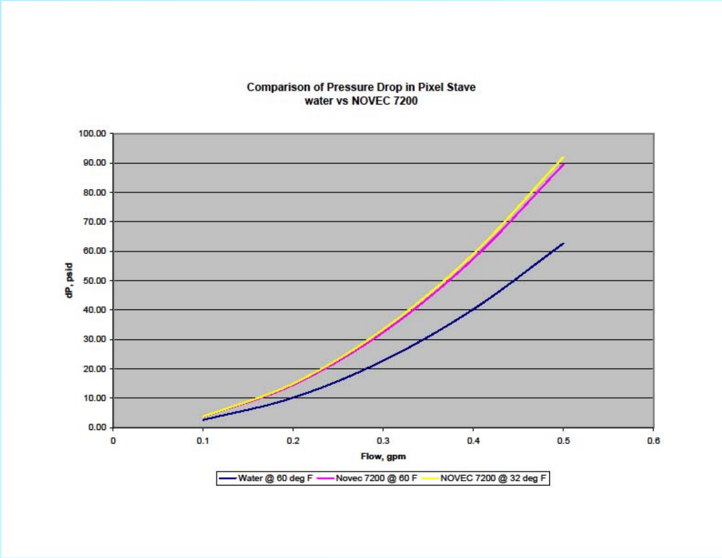
PHENIX





Test Results used to adjust pixel analytical flow model for choke point only. Strip pixel model required no adjustment.





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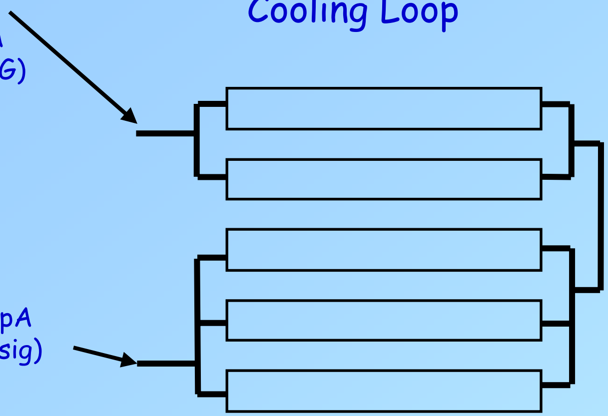
PHENIX

Internal loop designs which meet design requirements

Layers 1 and 2 Pixel Stave Cooling Loop

F_V= 17.3 ml/sec
Tin= -8 °C
Pin = 138 KpA (20 PSIG)

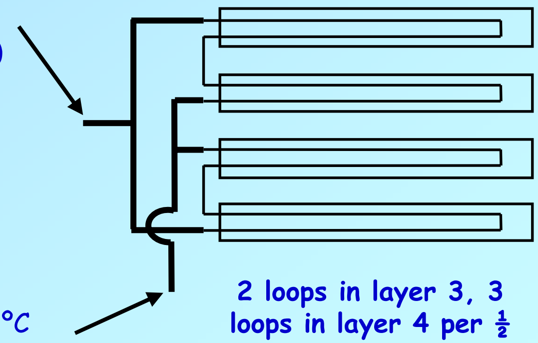


Tout= -4°C
Pout = 69 KpA (10 psig)

1 loop in layer 1, 2 loops in layer 2 per ½ detector

Layers 3 and 4 Strip-Pixel Stave Cooling Loop

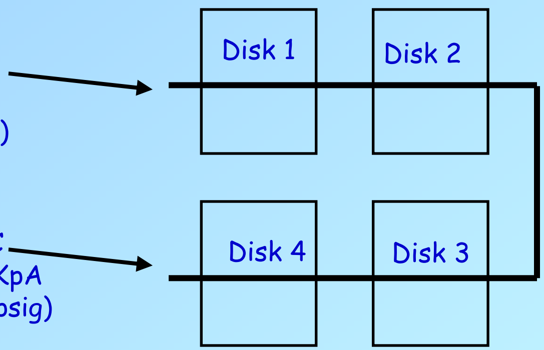
F_V= 27.6 ml/sec
Tin= -8 °C
Pin = 138 KpA (20 PSIG)



Tout= -6°C
Pout = 69 KpA (10 psig)

2 loops in layer 3, 3 loops in layer 4 per ½ detector

F_V= 19 ml/sec
Tin= -8 °C
Pin = 138 KpA (20 PSIG)



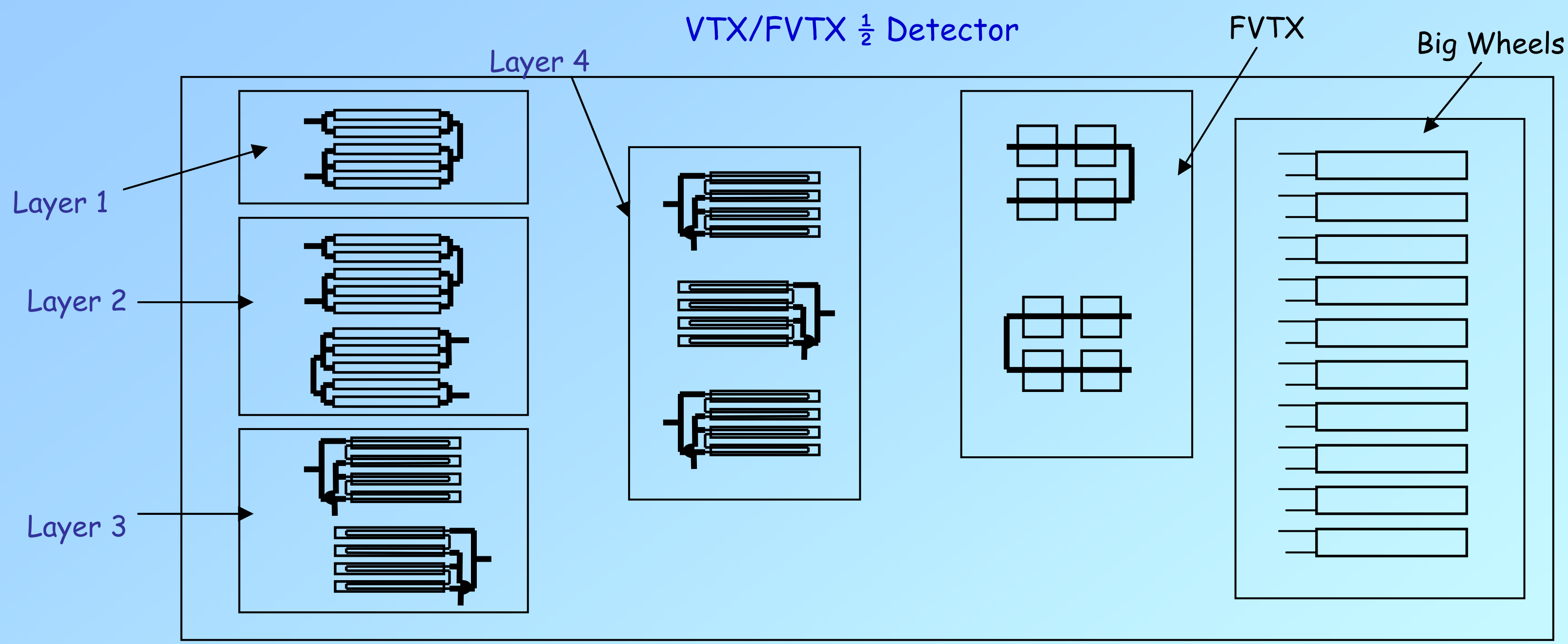
Tout= -7°C
Pout = 69 KpA (10 psig)

1 loop in north end, 1 loop in south end per ½ detector

FVTX Cooling Loop

Current Proposed Flow Concept

PHENIX

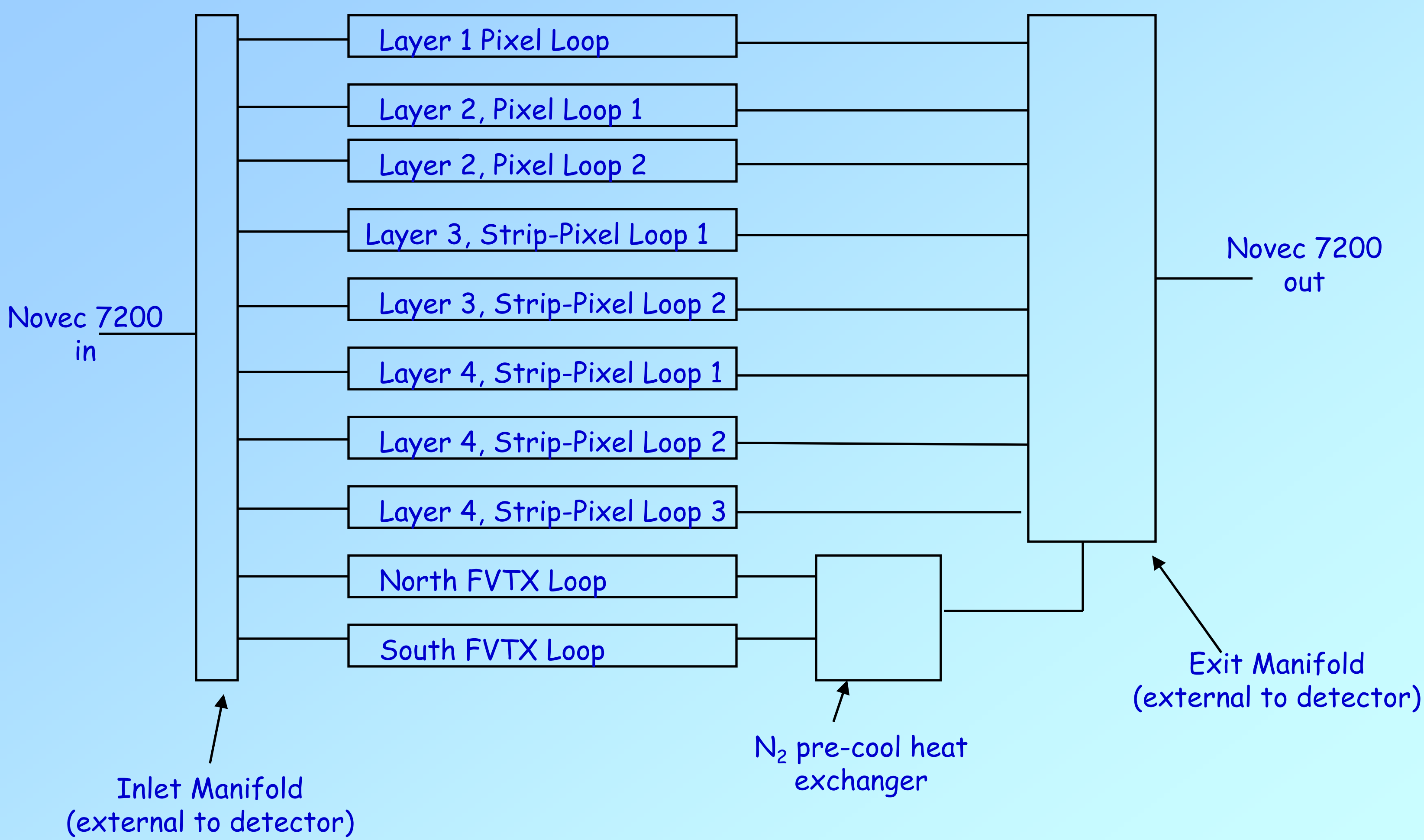


Notes: Calculations indicate that Pixels can be internally manifolded in sets of 3 in parallel with another set of 2 in series (was 5 in series). There would be one of these sets in layer 1 and 2 in layer 2. Strip pixels would be internally manifolded in sets of 2 staves in parallel with another set of 2 in series. (was 4 in series). 2 of these sets in layer 3 and 3 in layer 4. The pixels and strip pixels would be fed from a common external manifold and would be pressure balanced (flow ~50% higher in strip pixels).

Design Point: Coolant source pressure 30 psig. Supply and external inlet external manifold pressure drop 10 psid, internal manifold stave pressure drop 10 psid, exit manifold and return line pressure drop 10 psid.

PHENIX

VTX/FVTX Flow Schematic, ½ detector



VTX/FVTX Thermal Calculation Summary

Layer	Coolant	Number of loops/layer	# Circuits in parallel per loop	# of passes in series per loop	Fluid Inlet Temperature		Inlet Pressure		Flow rate in circuit		Total flow rate in loop	
					°F	°C	psig	kPa	gpm	ml/sec	gpm	ml/sec
1	Novec 7200	1	3[1]	2	17.5	-8	20	138	0.14	9	.27	17
2	Novec 7200	2	3[2]	2	17.5	-8	20	138	0.14	9	.27	17
3	Novec 7200	2	2	2	17.5	-8	20	138	0.22	14	.44	28
4	Novec 7200	3	2	2	17.5	-8	20	138	0.22	14	.44	27
FVTX	Novec 7200	2	1	4	17.5	-8	20	138	0.3	19	0.3	19

Layer	Total Loop Heat Load		Fluid Outlet Temperature		Loop Pressure drop		Maximum Sensor Temperature		Notes
	BTU/hr	Watts	°F	°C	psid	kPa	°F	°C	
1	450	132	25.	-34	10	70	67	20	[1] 2 circuits in 1st pass, 3 circuits in 2nd pass
2	450	132	25.	-4	10	70	67	20	[2] 2 circuits in 1st pass, 3 circuits in 2nd pass
3	340	100	22	-6	10	70	32	-0.3	
4	392	115	22	-6	10	70	32	0.1	
FVTX	500	146	25	-4	10[3]	70	66	19	[3] includesDisk 1 through 4 in series and N2 pre-cool heat exchenger

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After determining internal flow requirements, the inlet and exit piping requirements were analyzed with the following results:

Flow: ~7.5 gpm
Piping length: 100 feet each, inlet and outlet
Inlet and outlet ambient heat gain: 1.4 kW (total for inlet and outlet assumes moderately insulated piping)
Pipe size: 1 inch ID
Piping pressure drop: 8.45 psid inlet and same for outlet (maximum allowed 10 psid both sides)

VTX/FVTX Chiller Requirements (not including “Big Wheels”)

Coolant: Novec 7200

Flow rate: ~7.5 gpm

Coolant Supply Temp.: -9°C

Coolant Supply Pressure: 30 psig

Capacity: ~4 kW

Other: no copper piping to be used in coolant circuit.

2. VTX/FVTX readout electronics (“BigWheels”) cooling analysis.

PHENIX

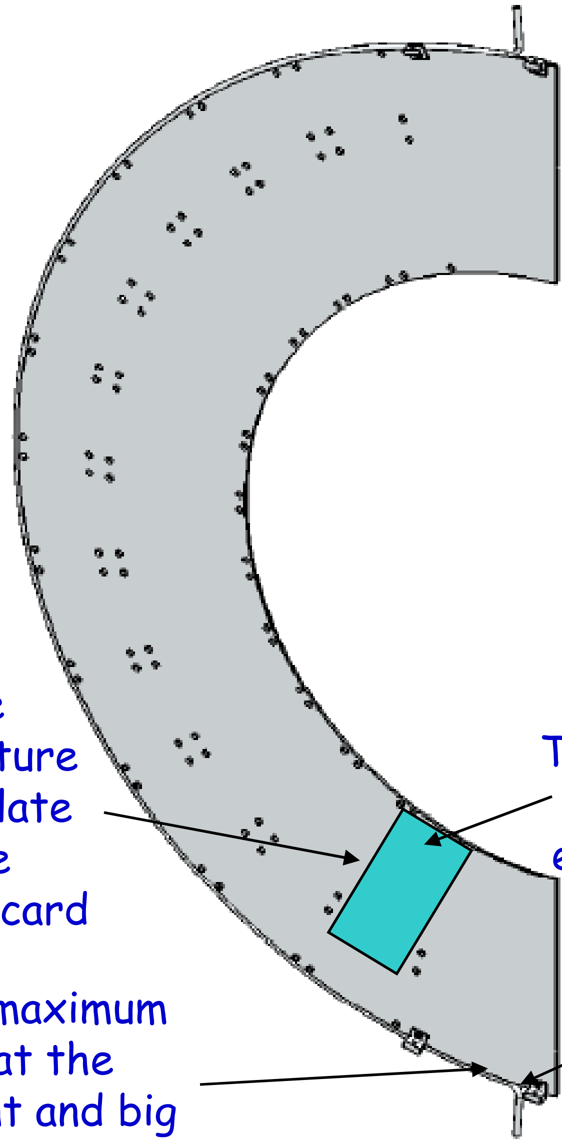
The analyses of the VTX and FVTX Big wheels considers the cooling problem as a series of conduction and convection heat flow analyses to determine the maximum temperature of the VTX and FVTX BigWheel mounted electronics as follows:

- Coolant bulk flow temperature rise (ΔT_b)
- Coolant bulk flow to tube wall (incl wall to tube OD) temperature rise (ΔT_w)
- Tube wall to BigWheel plate joint temperature rise (ΔT_j)
- Plate temperature rise (ΔT_p)
- Electronics card temperature rise (ΔT_c)

For the analyses it was assumed that the coolant source temperature was 10°C (50°F).

In addition, as several different electronics heat loads were reported, the greatest ones were used, and the average radial distance in the plate to the card heat load was calculated as a weighted average for the individual heatload sources form card components from information provided by Eric Mannel. For the joint temperature rise I assumed a joint thickness of .016” and calculated for both a thermal epoxy joint and a brazed joint. There was not enough information available to calculate the temperature rise from the aluminum plate to the hottest spot on the card, so a 10°C temperature rise was assumed for all cases, which is believed to be conservative.

$T_{b,in}$ – Coolant bulk inlet temperature



$\Delta T_b = T_{b,in} - T_{b,out}$

$\Delta T_w = T_w - T_{b,out}$

$\Delta T_J = T_J - T_w$

$\Delta T_p = T_p - T_J$

$\Delta T_c = T_c - T_p$ (note: for the purposes of this spec this is assumed to be 10°C

T_p – This is the maximum temperature at the big wheel plate adjacent to the electronics circuit card

T_c – This is the maximum temperature on the electronics circuit card

ΔT_w

T_J – This is the maximum temperature at the braze/epoxy joint and big wheel plate interface near the coolant outlet

T_w – This is the maximum temperature at the inner surface of the tube wall, near the coolant outlet

$T_{b,out}$ – Coolant bulk outlet temperature

Big Wheel Thermal Analysis Results

Plate	Flow Rate ml/sec	Coolant In °C	ΔT_b °C	Δ Tw °C	ΔT_j (epoxy) °C	ΔT_j (braze) °C	ΔT_p °C	ΔT_c °C	Coolant out °C	Max Card Temp. °C (epoxy)	Max Card Temp. °C (braze)
1	23.7	10.0	1.3	1.7	14.8	0.2	11.2	10.0	11.3	49.0	34.4
2A	23.7	10.0	1.3	1.7	14.4	0.2	9.0	10.0	11.3	46.4	32.2
2B	23.7	10.0	1.3	1.7	14.4	0.2	9.0	10.0	11.3	46.4	32.2
3	23.7	10.0	1.9	2.7	23.4	0.4	13.0	10.0	11.9	61.0	38.0
4	23.7	10.0	2.9	3.8	32.5	0.5	18.0	10.0	12.9	77.1	45.2
FVTX	23.7	10.0	2.8	2.8	24.3	0.4	15.8	10.0	12.8	65.8	41.9

Plate	Heat Load per Card Watts	Heat Load per Plate Watts
1	20.5	102.5
2A	20.5	102.5
2B	20.5	102.5
3	19.6	156.4
4	19.6	234.6
FVTX	38.0	228.1

Conclusion: Use braze joint for tube attachment. Vacuum or dip braze.

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VTX/FVTX Chiller Requirments ("Big Wheels")

Coolant: NOVEC 7200

Flow rate: 7.5 gpm (minimum)

Coolant Supply Temp.: 10 °C

Coolant Supply Pressure: 50 psig

Capacity: ~3.0 kW minimum